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PRETEST REPORT FOR TESTS OF AN APOLLO TUMBLING DYNAMIC STABILITY MODEL WITH CANARDS (FD-9) IN THE LEWIS RESEARCH CENTER 8- BY 6-FOOT SUPERSONIC WIND TUNNEL NAS9-150

July 1964

Exhibit I, Paragraph 5.5

~~AVAILABLE TO NASA HEADQUARTERS ONLY~~

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

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FOREWORD

The tests described in this report are to be conducted under NASA Apollo contract NAS9-150, paragraph 5.5, exhibit I in the Lewis Research Center 8- by 6-foot supersonic wind tunnel.

This report was prepared by G. A. Udvardy of the Experimental Aerodynamic Unit, Space and Information Systems Division.

ABSTRACT

This report presents the objectives of free oscillation dynamic stability tests of an Apollo 0.059-scale model, and describes the model and instrumentation. Test procedure, run schedule, and data requirements are outlined.

The tests of the command module and the launch escape vehicle, with and without canards, are to be conducted at the Lewis Research Center 8- by 6-foot supersonic wind tunnel during the month of September.

INTRODUCTION

The primary objective of the tests described herein is the acquisition of static-moment and dynamic data to be used to define the tumbling dynamic characteristics of the command module and the launch escape vehicle with and without the canard. Test instrumentation is designed to permit on-site calculation of the dynamic stability parameters and high accuracy post test evaluations.

The models, for both the static and dynamic tests, will be mounted on a transverse rod supported at both ends by a ball-bearing pivot which will allow 360-degree freedom of rotation in the pitch plane. The model will be restrained in pitch by a cantilevered beam instrumented with strain gauges to give model moment data during the static portion of the test. For the dynamic tests the beam will be disconnected.

The test configurations include the command module ($C_2V_{10}u_2a_2$), the launch escape vehicle with canard ($C_2V_{10}u_2a_2T_{87}E_{78}$), and without canard ($C_2V_{10}u_2a_2T_{87}E_{79}$). The rotational center will be at the center of gravity for the command module alone configuration. For the launch escape model, the longitudinal c.g. location is correct. However, due to model space limitations the vertical c.g. displacement could not be duplicated resulting in a centerline location.

The tests will be made at dynamic pressures of 900 and 700 PSF at Mach numbers of 1.6 and 2.0.

Models, model drawings, and model photographs are unclassified. Raw identified and reduced data are to be considered as confidential.

I. MODEL DESCRIPTION

The models will be mounted midway on a transverse rod for both the dynamic and static tests. The transverse rod is supported at both ends by ball bearings located in the main support and rotates with the model. Figures 11 through 14 are drawings of the tunnel installation, models, supports, and mechanisms.

MODEL SUPPORT SYSTEM

The main support consists of a two-pronged sting fitted to the tunnel sting support. The upstream forked end, which supports the transverse rod, is supported by the tunnel side walls (Figure 1). The left side of the fork (looking downstream) contains motors, drivers, and electrical cables necessary for driving the model to predetermined angles of attack. The right side contains the instrumentation package which includes the photo drum, the serrated disc, and two magnetic pickups (Figure 2) which are used in conjunction with a computer to determine model position and velocity. Each side also contains a brake system to release and stop the model for each data run.

STATIC MODEL

The models for the static tests will be mounted on a ball-bearing sleeve midway on the transverse rod and will be restrained in pitch by a cantilever beam instrumented with strain gauges to give model static pitching moment data. During this portion of the test the instrumentation package will give model position only. Data will be taken at 10-degree increments through 360 degrees. The model drive mechanism will drive the model between the data points at a rate of 3 degrees per second.

DYNAMIC MODEL

The models for the dynamic tests will be mounted in the same manner as the static model. The cantilever beam, however, will be disconnected to allow complete rotational freedom in the pitch plane. The instrumentation package will be completely activated to give angular positions and velocity. Motion pictures will be taken of the photo drum to provide backup data. The drive mechanism will be used to position the model to a given release angle, then disengaged after the brake has been applied to hold the model at that position. The brake will then be used to release and stop the model for each data run.

MODELS

The FD-9 configurations are 0.059-scale models of (1) the command module ($C_2V_{10}u_2a_2$), (2) the launch escape vehicle ($C_2V_{10}u_2a_2T_{87}E_{79}$), and (3) the launch escape vehicle with canards ($C_2V_{10}u_2a_2T_{87}E_{78}$). (See Table 1 and Figures 3 through 5.) All external protuberances have been simulated on the command module. The models of the command module have been fabricated from aluminum alloy castings. The escape tower consists of a structure of welded stainless steel tubing. The canards are machined of stainless steel. The models have been stressed in accordance with NASA Specifications.*

The models will be ballasted for scale moment-of-inertia simulation and balanced at the NAA model shop, with a final check taking place during the tunnel installation period.

INSTRUMENTATION

Dynamic Tests

The instrumentation consists of two packages: referred to as the data acquisition unit and the data reduction unit located inside and outside the tunnel, respectively.

The data acquisition unit consists basically of two magnetic sensors positioned on either side of a spinning serrated disc whose center of rotation coincides with the model rotation center (Figure 2) and is located in the right arm looking downstream. The serrations consist of gear teeth machined into the outer two faces of the disc. The disc and its drive motor plus one sensor are located on the transverse rod support with the second sensor rotating with the model and support rod.

Each sensor consists of a permanent magnet core insulated from a surrounding metallic sleeve to which a wire lead is attached. The flux emitted by the magnet flows to the outer sleeve of the pickup and is measured as a voltage. As each tooth and valley of the disc passes a pickup, the flux path length alternately increases and decreases causing a fluctuation of output voltage. The electric signal from each tooth and valley combination constitute one cycle. The disc is driven at a constant 1800 rpm and has 500 teeth on each surface. This means the stationary pickup is sensing or measuring a constant 15,000 cps. This holds true also for the pickup attached to the model when the model is motionless. However, when the model is in motion, the moving pickup senses a higher or lower number of

*Manual NASA Lewis 8- by 6-foot Supersonic Wind Tunnel. Lewis Research Center, Cleveland, Ohio (February 1959).

cycles depending on its rotational velocity and direction of rotation. The signals from the pickups are introduced to the data reduction unit (Q-360 data display and translator) which reduces them to model attitude and angular velocity as described in Section III. This is then recorded on direct writing oscillographs and magnetic tape. Sixteen-millimeter motion pictures at 400 frames per second will be taken simultaneously with the electronic data acquisition unit. The movies will be used as backup should the data acquisition system fail. As a time base tie-in, a timing mark will be placed electronically on the film and the acquisition record at the instant of model release. The camera will be sighted on a marked drum target placed on the brake drum which rotates with the model. In the painting of the drum an attempt was made to obtain the greatest amount of accuracy in the space alotted. The drum is divided into four quadrants. Each quadrant is equal to 90 degrees, as shown on Figure 2. Each quadrant is distinctively marked so as to alleviate any error in data reduction. By reading the ratio of light to dark and comparing it to the calibration curve, model angle of attack can be determined to an accuracy of ± one degree.

Static Tests

The ball-bearing mounted model is restrained in rotational motion by a strain gauge instrumented cantilever beam (Figure 7). The gauge electrical outputs will be fed to the automatic voltage digitizers (AVD). Model angle of attack will be provided by the Q-360 data display and translator.

II. OPERATIONS

The test program consists of static tests followed by dynamic tests. (See Run Schedules, Tables 2 and 3.) The static tests will be conducted first to obtain static moment data, which, in conjunction with data from the dynamic tests following, will allow preliminary on-site evaluation of the equations of motion.

STATIC TESTS

The static tests, as shown in the Run Schedule, will be conducted at Mach numbers 1.6 and 2.0 and at dynamic pressures of 900 and 700 psf respectively. The test procedure for each configuration and each test condition will be as follows.

1. With wind-off, angle-of-attack indicator, and strain gauge output signal will be zeroed.

2. With drive energized, the initial model attitude will be set.

3. Brakes will be on high pressure and the drive mechanism energized.

4. Tunnel test conditions will be established.

5. Brakes will be released.

6. Model angle of attack, strain gauge output, and test conditions will be fed to computer.

7. Model will be driven to the next attitude.

8. Steps 6 and 7 will be repeated for the entire angle-of-attack range.

9. Before tunnel shut-down the brakes will be applied.

DYNAMIC TESTS

The dynamic tests will be conducted at the same tunnel conditions noted above for the static tests. The procedure of each test will be as follows.

Wind-Off

1. With the brakes off, the drive mechanism energized, and the data acquisition system operating, the model angle-of-attack indicator will be zeroed at 0 degrees angle of attack.

2. Brakes will be applied at high pressure.

Wind-On

1. Tunnel conditions will be established.

2. With drive mechanism energized the brakes will be released and the model will be driven to the required release attitude.

3. Brakes will be applied at high pressure. The drive mechanism will be de-energized.

4. Just prior to model release, approximately three seconds, the motion picture camera and recording oscillograph will be set in motion.

5. The model will be released.

6. The magnetic pickup outputs (in form of α and $\dot{\alpha}$) will be recorded on magnetic tape and direct writing recording oscillographs.

7. Brakes will be applied to stop the model motion.

8. The motion picture camera, tape recorders, and oscillographs will be stopped.

9. Steps 2 through 8 will be repeated for each of the remaining release angles.

Should the model, after release, go into a tumbling condition, it will be braked to a stop after one or two revolutions. The estimated duration of each data run is less than 10 seconds.

III. DATA REDUCTION

STATIC TESTS

The static moment strain-gauge data will be reduced on-site using the automatic voltage digitizers (AVD). Data are to be reduced using the following equation.

$$C_{m_{cg}} = \frac{M}{qSd}$$

where

M = Measured moment
q = Dynamic pressure (psi)
S = Reference area (64.837 in.^{2})
d = Reference diameter (9.086 in.)

Reference c.g. dimensions for the three configurations are:

Axis	$C_2V_{10}u_2a_2$	$C_2V_{10}u_2a_2T_{87}E_{79}$	$C_2V_{10}u_2a_2T_{87}E_{78}$
$\overline{X}$, inches measured from theoretical apex	5.755	0.944	0.944
$\overline{Z}$, inches measured from command module C_L	0.360	0	0

DYNAMIC TESTS

The system of accumulating and evaluating the signals from the magnetic pickups is illustrated in Figure 6.

The model attitude reference is set by zeroing the display counter with the model at zero degrees angle of attack. The model attitude indication, independent of time, is based on the position of the moving pickup with respect to the stationary one. The velocity indication depends only on the moving pickup. The electrical signals from the pickups are introduced to the data display and translator boxes which sample differentiate the signals at 0.001 second intervals to give model attitude and angular velocity. These outputs, α and $\dot{\alpha}$, along with a time base are recorded simultaneously on magnetic tape and a recording oscillograph.

The method employed in reducing the dynamic data is intended to give aerodynamic damping as a function of angle of attack. This is unlike reduction techniques used in forced oscillation and limited (sting-supported model) free-oscillation techniques, which give aerodynamic damping as a function of a forced trim angle of attack or as a function of oscillation amplitude. Angle-of-attack time histories and static pitching moment data measured during the test are the primary inputs into the data reduction technique. Angular velocity time histories, also measured, are used as a check of the data reduction.

The procedure followed in obtaining the aerodynamic damping involves the solution of the equation of motion of the wind tunnel model. This equation is:

$$I\ddot{\alpha} - (C_{m_q} + C_{m_{\dot{\alpha}}})\frac{\dot{\alpha}\,\bar{q}Sd^2}{2V} - C_m\bar{q}Sd = \pm T_f$$

where

I = the model pitch moment of inertia, slug-ft^2

$\ddot{\alpha}$ = the model angular acceleration, rad/sec/sec

$\dot{\alpha}$ = the model angular velocity, rad/sec

$(C_{m_q} + C_{m_{\dot{\alpha}}})$ = the aerodynamic damping

$\bar{q}$ = the wind tunnel dynamic pressure, psf

S = the model reference area, ft^2

d = the model reference diameter, ft

V = the wind tunnel velocity, ft/sec

C_m = the static pitching moment coefficient

T_f = the frictional torque, ft/lb

A single degree of freedom digital computer program is available to solve the above differential equation to give angle of attack and angular velocity time histories. All information is known except $(C_{m_q} + C_{m_{\dot{\alpha}}})$ as a function of angle of attack. By assuming $(C_{m_q} + C_{m\dot{\alpha}})$ functions the program is run in a trial-by-error method until the angle time histories measured are matched by the computer for a given $(C_{m_q} + C_{m\dot{\alpha}})$ function. The angular velocity history should then be checked to assure good correlation between the measured values and computer correlation values. The reduced data are, therefore, the $(C_{m_q} + C_{m\dot{\alpha}})$ functions that give the best computer correlation with the wind tunnel angle-of-attack time history measurement.

IV. DATA PRESENTATION

TABULATED DATA

North American Aviation, Inc., has a contractual obligation to provide NASA with a tabulated data report within thirty days after completion of each wind tunnel test. In order to meet this requirement, it will be necessary to have a complete set of tabulated data, in reproducible form, no later than 10 working days after completion of each test. A copy of the wind tunnel log should also be provided.

Tabulated data should be identified by test and run number and should omit identified column headings to permit handling as unclassified material. A key for identifying the tabulated data is to be provided and classified as confidential.

STATIC TESTS

Test parameters to be tabulated by LeRC 8- by 6-foot supersonic wind tunnel will include:

- Run number
- Mach number
- Velocity
- Dynamic pressure
- Reynolds number
- Angle of attack
- Pitching moment coefficient

DYNAMIC TESTS

Test parameters to be tabulated by LeRC 8- by 6-foot supersonic wind tunnel will include:

- Run number
- Mach number
- Velocity
- Dynamic pressure
- Reynolds number
- Release angle of attack

The dynamic test data reduction and presentation will be the responsibility of NAA. Tabulation of the test results will include:

Release angle of attack
Time base
Frequency
Damping-in-pitch parameters

Four copies of the final tabulation static data and test conditions from the dynamic test are required and should be distributed as follows:

1. Letter of transmittal and two copies (one reproducible) of the tabulated data and tunnel log to:

   North American Aviation, Inc.
   Space and Information Systems Division
   12214 Lakewood Boulevard
   Downey, California
   Attention: Mr. Edwin C. Allen, Dept. 696-714

   Through: NASA Apollo Program Office
   North American Aviation, Inc.
   12214 Lakewood Boulevard
   Downey, California
   Attention: Mr. E.E. Sack

2. One copy of the transmittal letter and one copy of the data plus run log to:

   Mr. Calvin H. Perrine
   PE 3
   NASA Manned Spacecraft Center
   Houston, Texas 77058

3. One copy of the transmittal letter and one copy of the tabulated data including tunnel run log to:

   NASA Manned Spacecraft Center
   Spacecraft Technology Division
   Houston, Texas
   Attention: Mr. W. C. Moseley, Jr.

Table 1. Basic Model Dimensions
(Model Scale = 0.059)

Item	Full Scale	Model Scale
Tower structure, T_{87} (Figure 11)		
Length, in.	120.0	7.08
Number of longitudinal members	4	4
Diameter of longitudinal members, in.	4.16	0.245
Diameter of cross braces, in.	2.78	0.164
Circular truss		
Diameter of material, in.	2.78	0.164
Diameter of circle, in.	23.00	1.360
Distance between points at command module		
Horizontal plane, in.	50.66	2.985
Vertical plane, in.	46.85	2.762
Distance between attach points at base of rocket, in.	36.06	2.125
Command module, C_2 (Figure 11)		
Maximum diameter, in.	154.00	9.08
Radius of spherical blunt end, in.	184.4	10.87
Corner radius, in.	7.7	0.453
Nosecone semi-angle, deg	33.0	33.0
Nosecone vertex radius, in.	9.152	0.540
Vent, V_{10} (Figure 11)		
Total length, in.	17.333	1.023
Width, in.	2.667	0.157
Height, in.	2.667	0.157
Angle of beveled end, deg	53.0	53.0
Escape Rocket, E_{79}		
Total length, in.	279.67	16.48
Diameter, in.	26.0	1.533
Nosecone semi-angle, deg	75.0	15.0
Nosecone vertex radius, in.	2.0	0.118
Skirt semi-angle, deg	34.0	34.0

Table 2. Static Test Run Schedule

Angle of Attack (α) (Deg)	Mach No. 1.6	Dynamic Pressure q psf 900	Mach No. 2.0	Dynamic Pressure q psf 700	Configurations
	CONFIGURATION TO BE TESTED				
0	1, 2, 3		1, 2, 3		1. $C_2V_{10}u_2a_2$
10					
20					2. $C_2V_{10}u_2a_2T_{87}E_{79}$
30					
40					3. $C_2V_{10}u_2a_2T_{87}E_{78}$
50					
60					(Canards)
70					
80					
90					
100					
110					
120					
130					
140					
150					
160					
170					
180	1, 2, 3		1, 2, 3		
190	1, 3		1, 3		
200					
210					
220					
230					
240					
250					
260					
270					
280					
290					
300					
310					
320					
330					
340					
350	1, 3		1, 3		

Table 3. Dynamic Test Run Schedule

Angle of Attack (α) (Deg)	Mach No.	Dynamic Pressure q psf	Mach No.	Dynamic Pressure q psf	Configurations
	1.6	900	2.0	700	
	CONFIGURATION TO BE TESTED				
0	1, 2, 3		1, 2, 3		1. $C_2V_{10}u_2a_2$
30	2, 3		2, 3		2. $C_2V_{10}u_2a_2T_{87}E_{79}$
150	1, 2, 3		1, 2, 3		3. $C_2V_{10}u_2a_2T_{87}E_{78}$ (Canards)

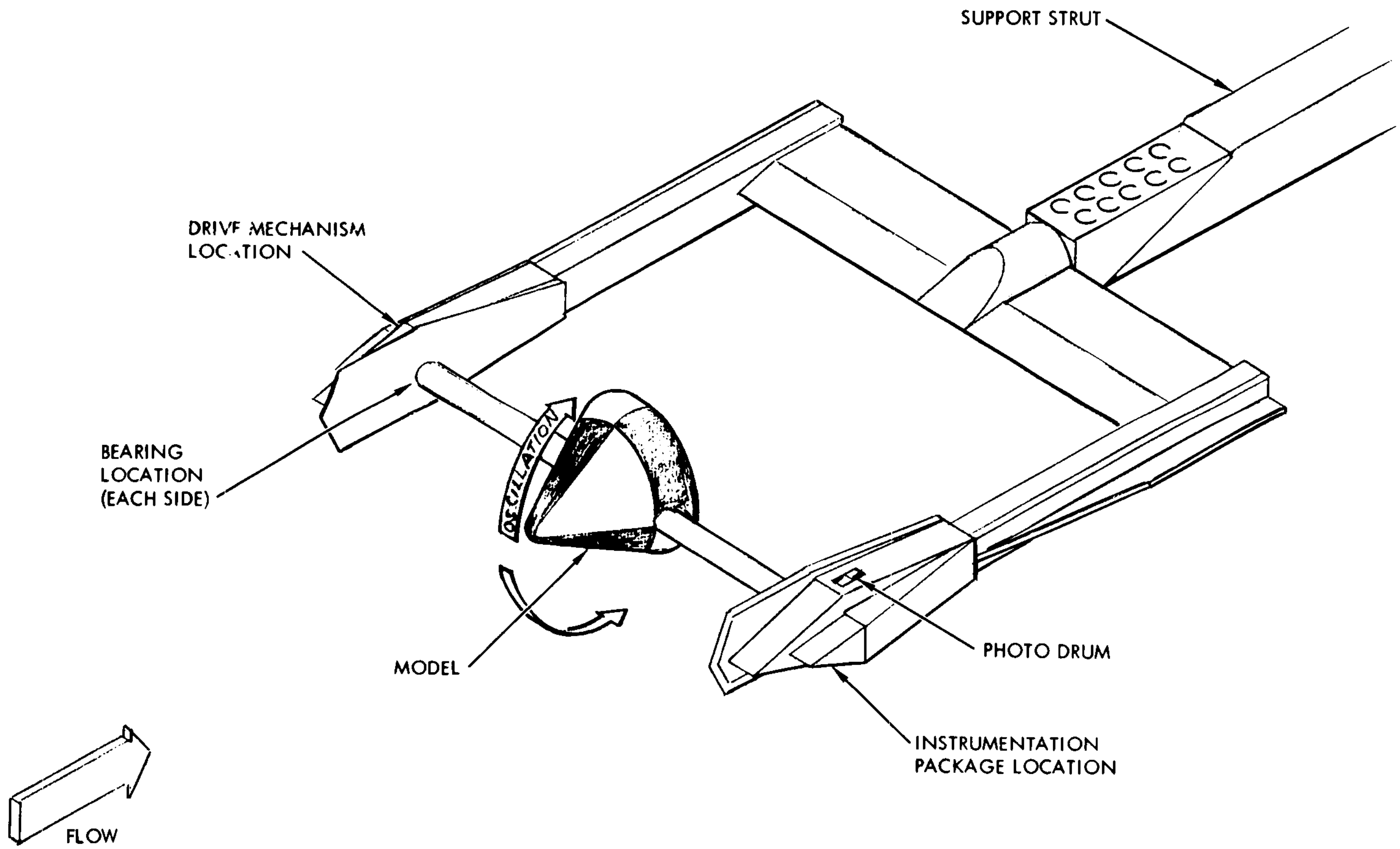


Figure 1. Model Installation

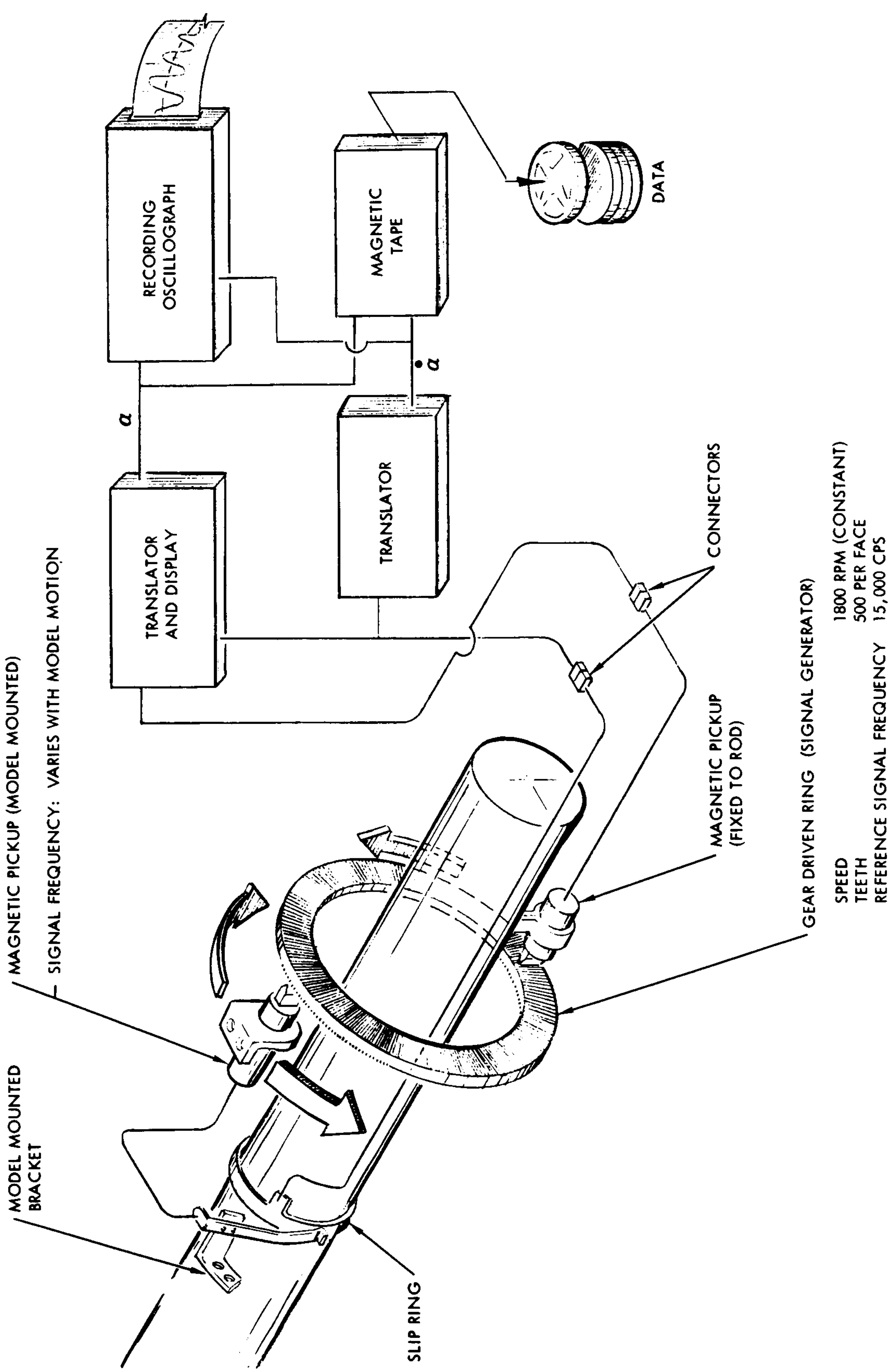


Figure 2. Data Acquisition System

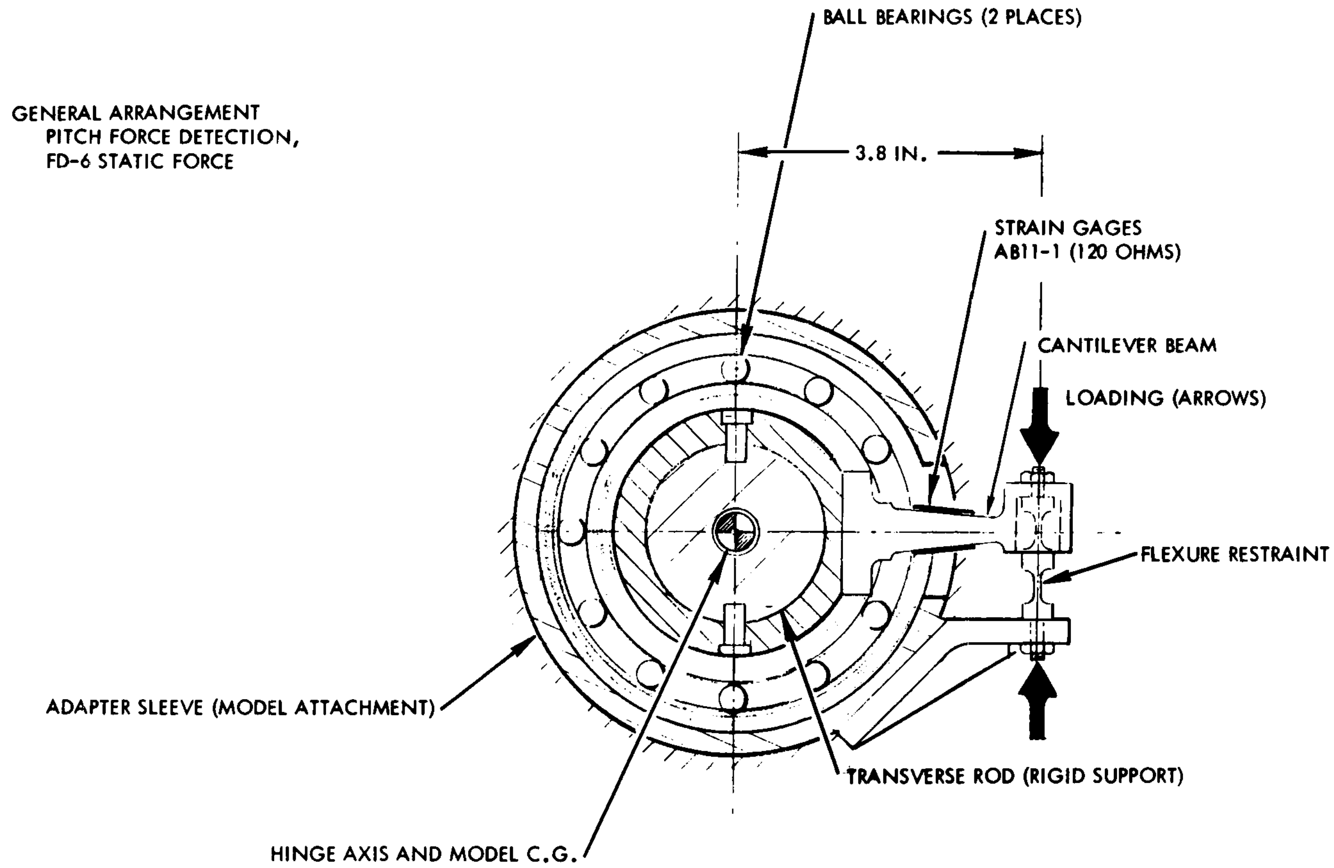


Figure 3. Static Moment Data

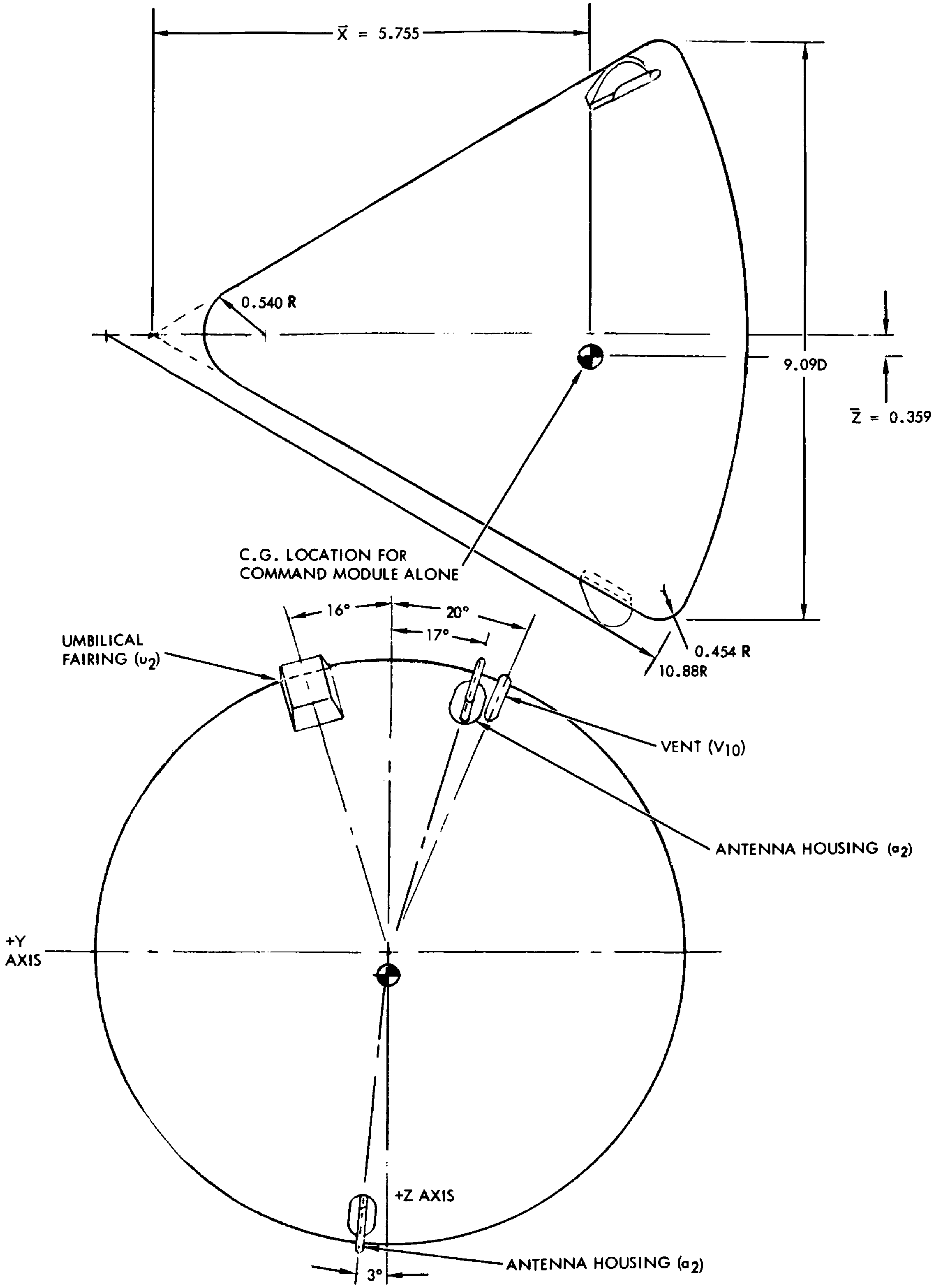


Figure 4. Basic Model Dimensions $(C_2V_{10}u_2a_2)$

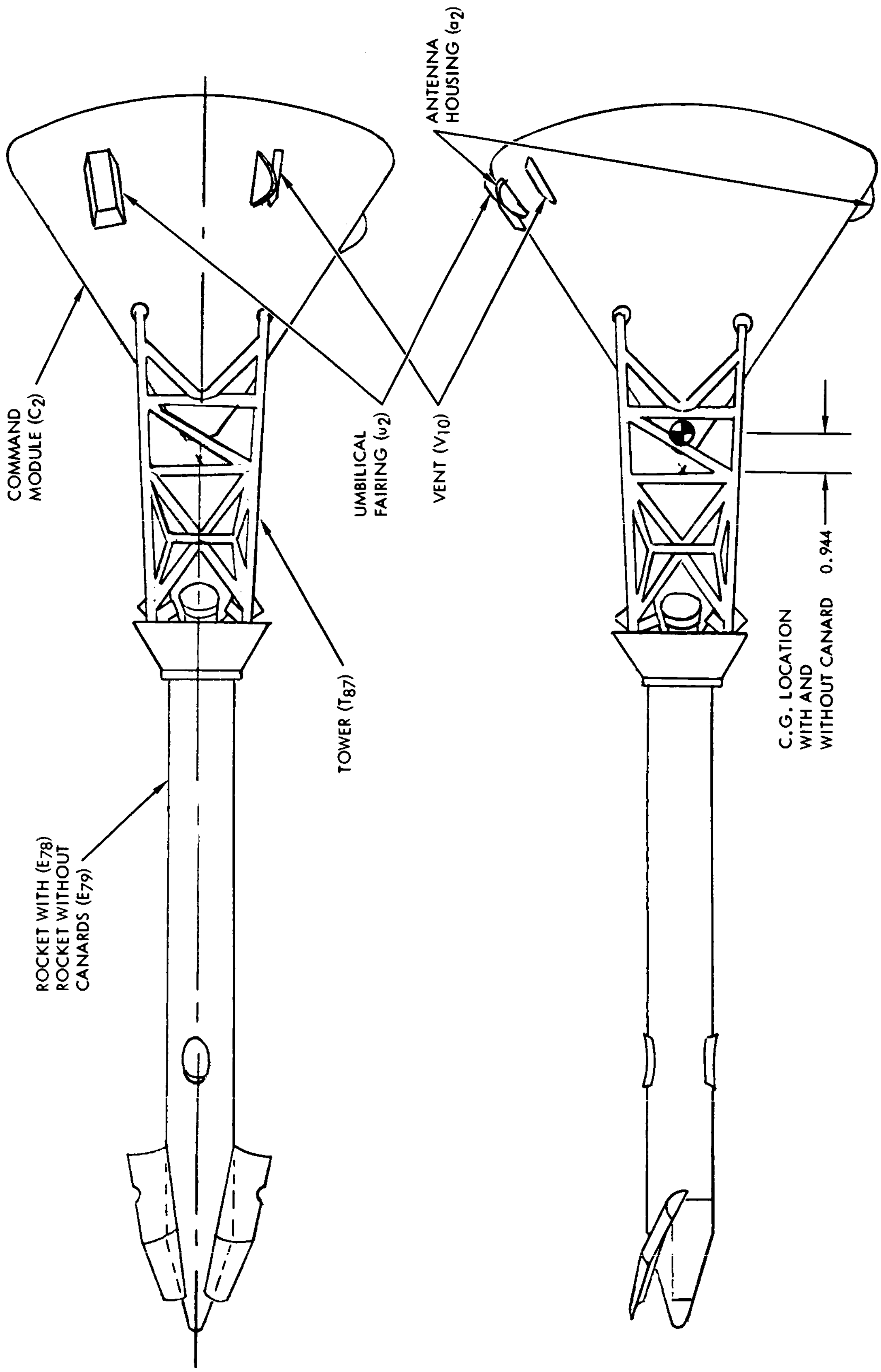


Figure 5. Post-Abort Configuration ($C_2 V_{10} u_2 a_2 T_{87} E_{79}$)

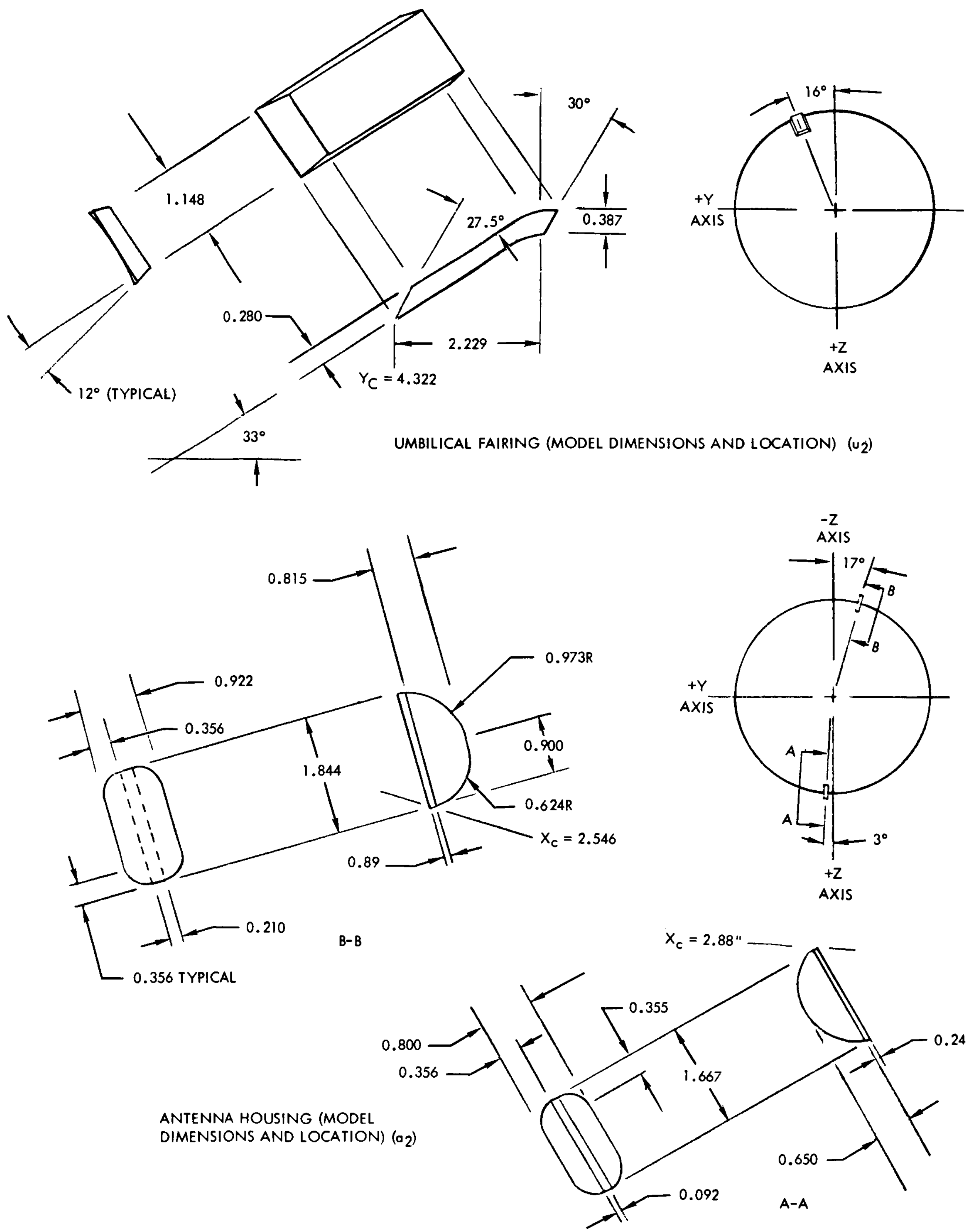


Figure 6. Model Components

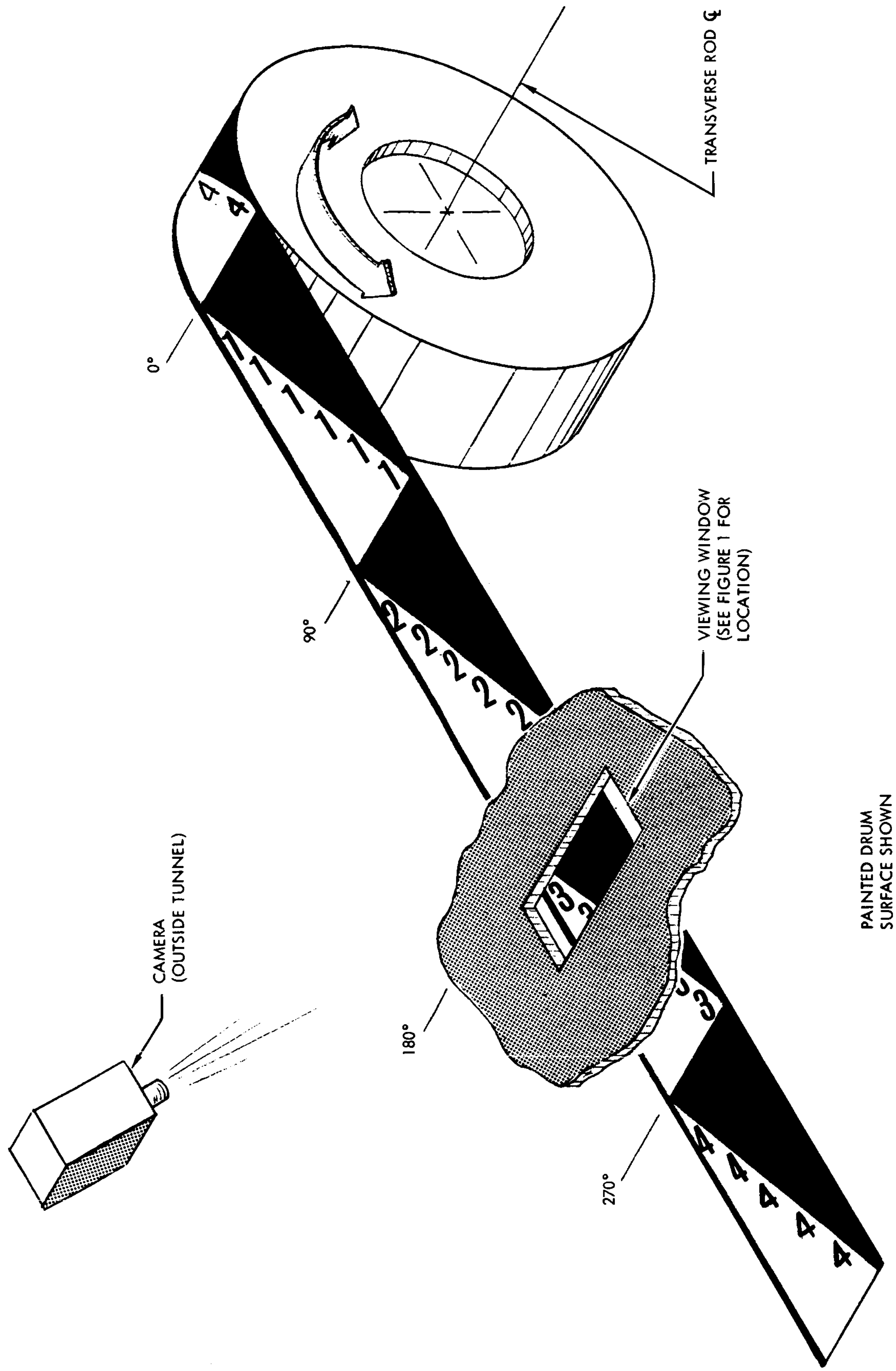


Figure 7. Photographic Drum

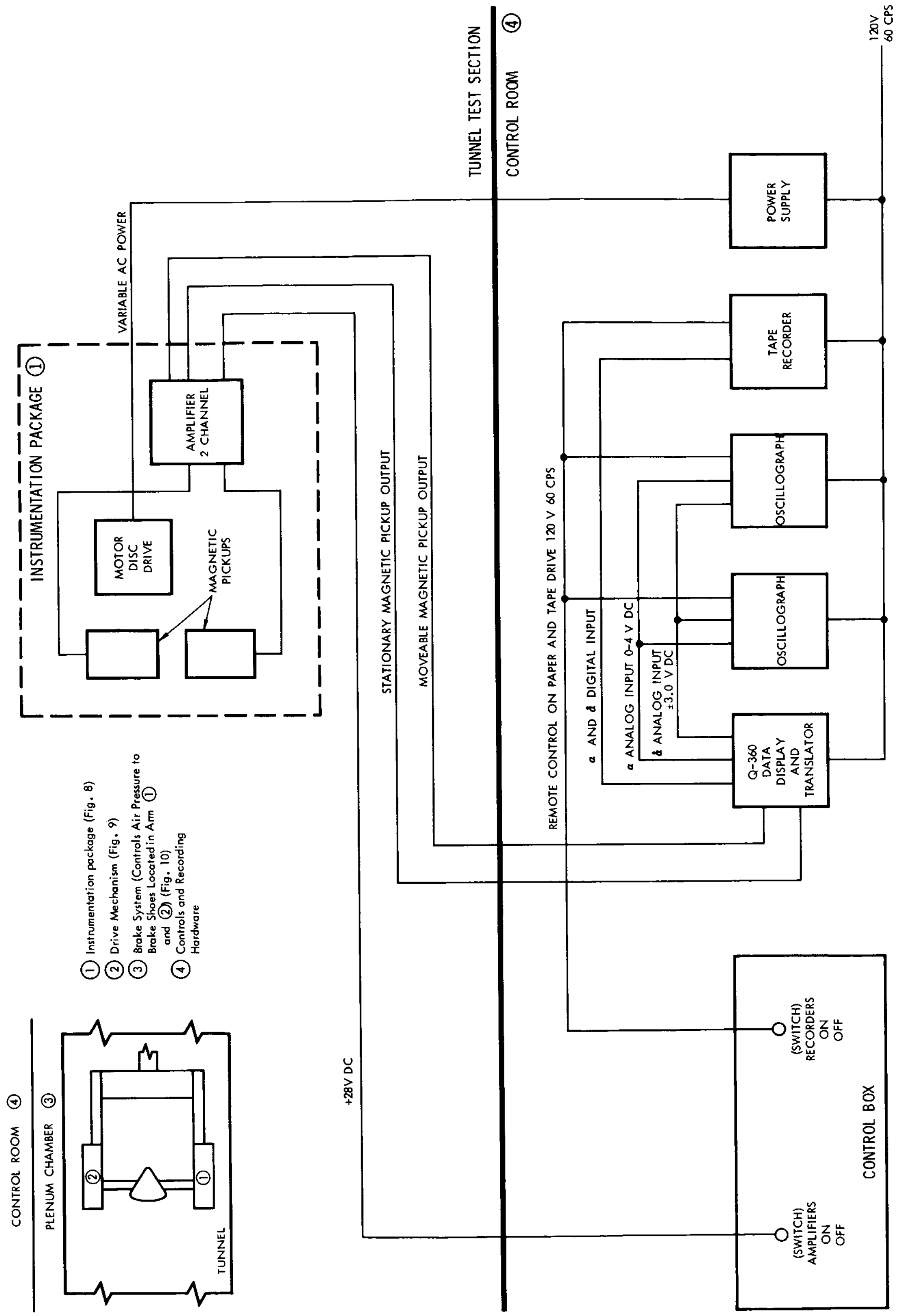


Figure 8. Instrumentation Wiring Schematic

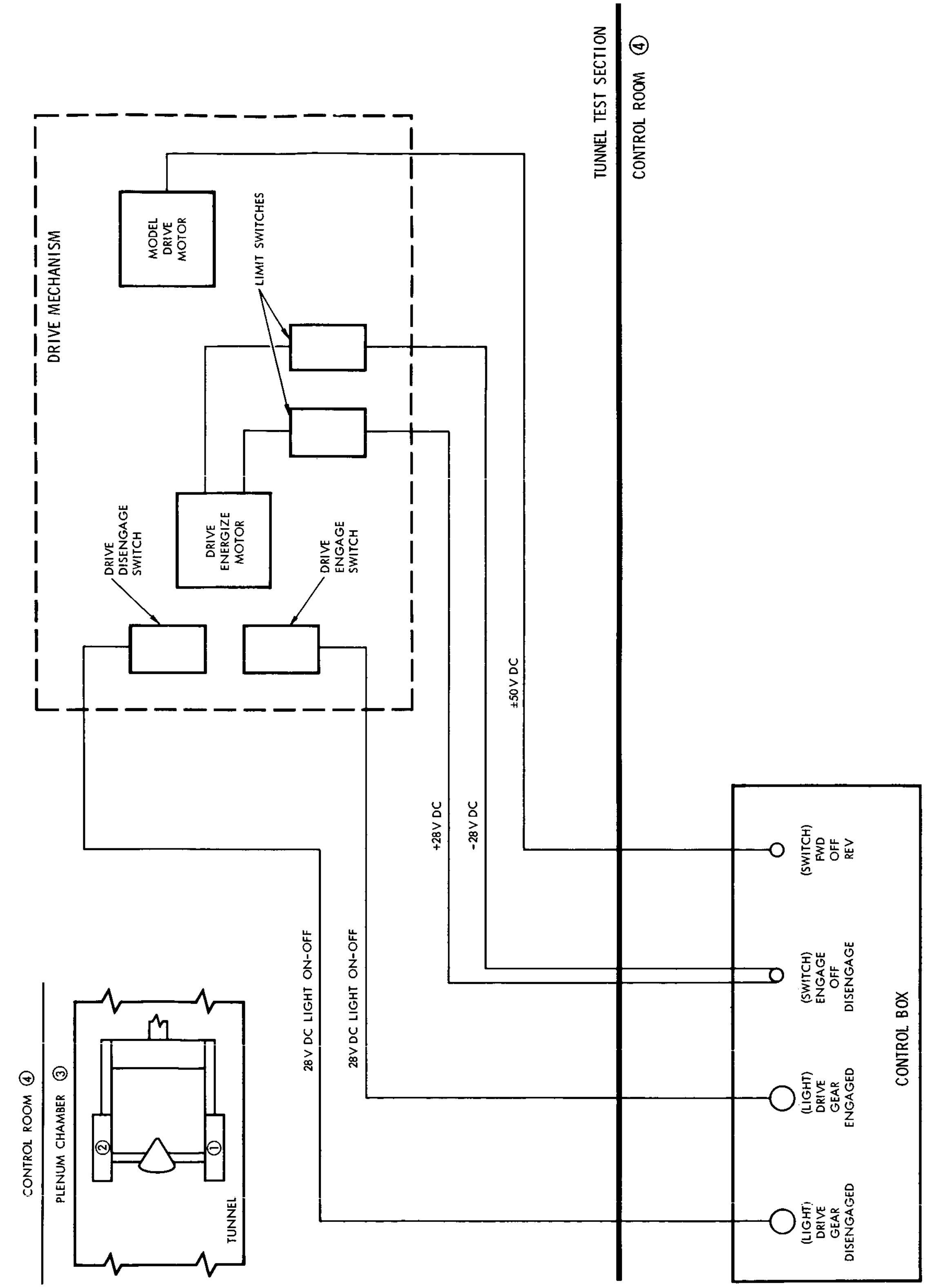


Figure 9. Drive Mechanism Wiring Schematic

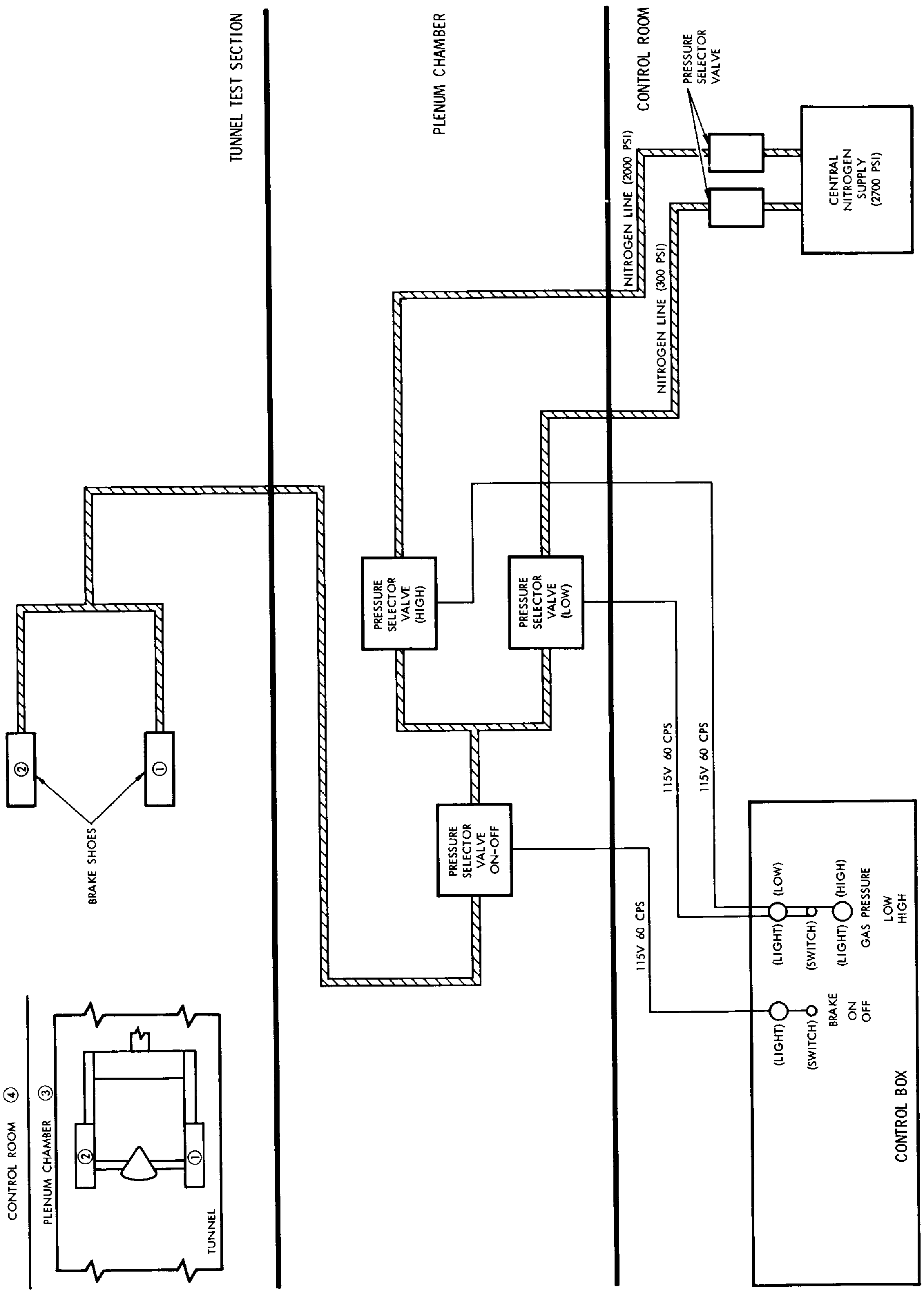
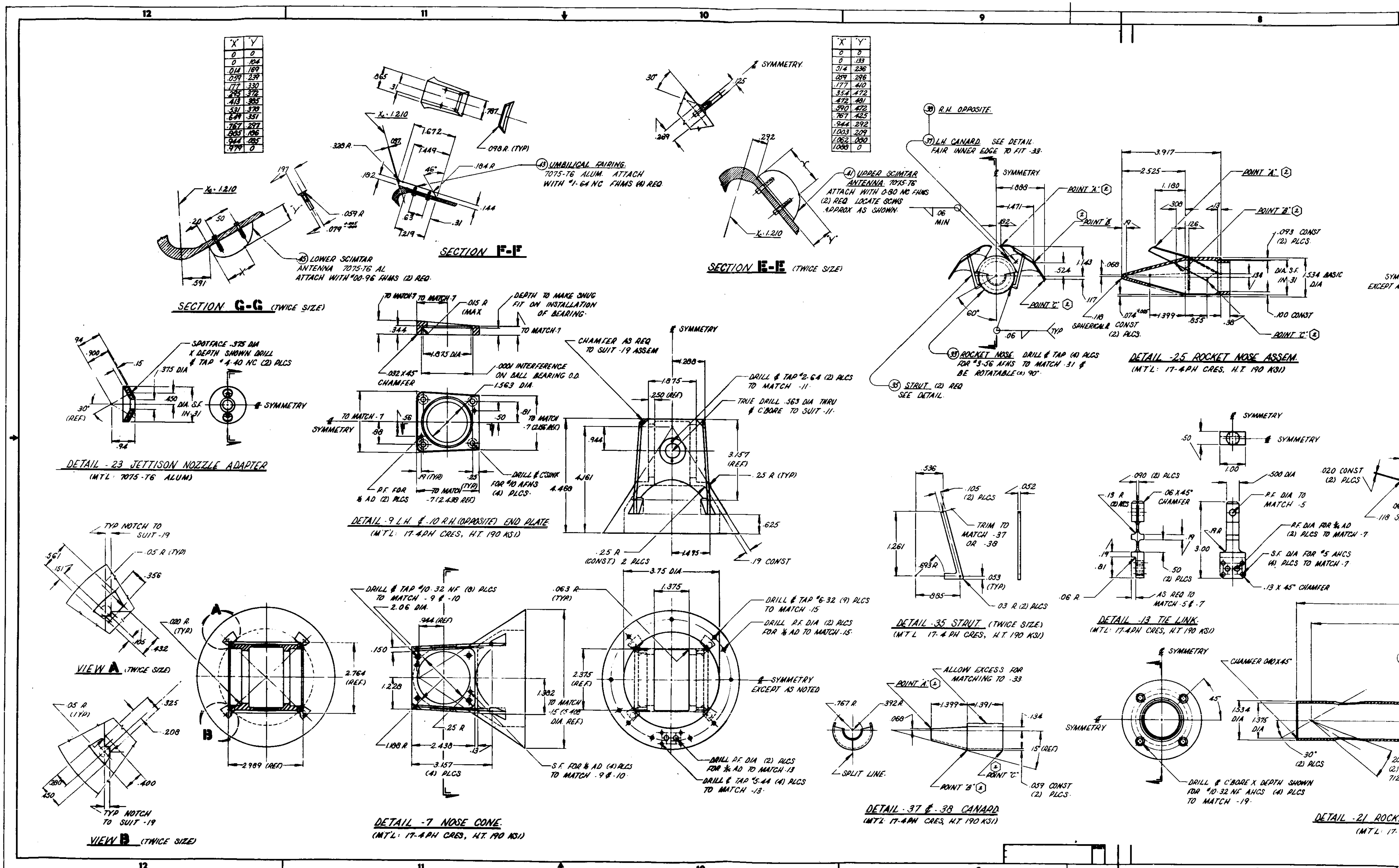


Figure 10. Brake System Wiring and Gas Line Schematic



"X"	"Y"
0	0
0	.104
.014	.169
.059	.239
.177	.330
.295	.372
.413	.385
.531	.378
.649	.351
.767	.297
.885	.186
.944	.085
.979	0

"X"	"Y"
0	0
0	.133
.014	.236
.059	.296
.177	.410
.354	.472
.472	.481
.590	.472
.767	.425
.944	.292
1.003	.209
1.062	.080
1.088	0

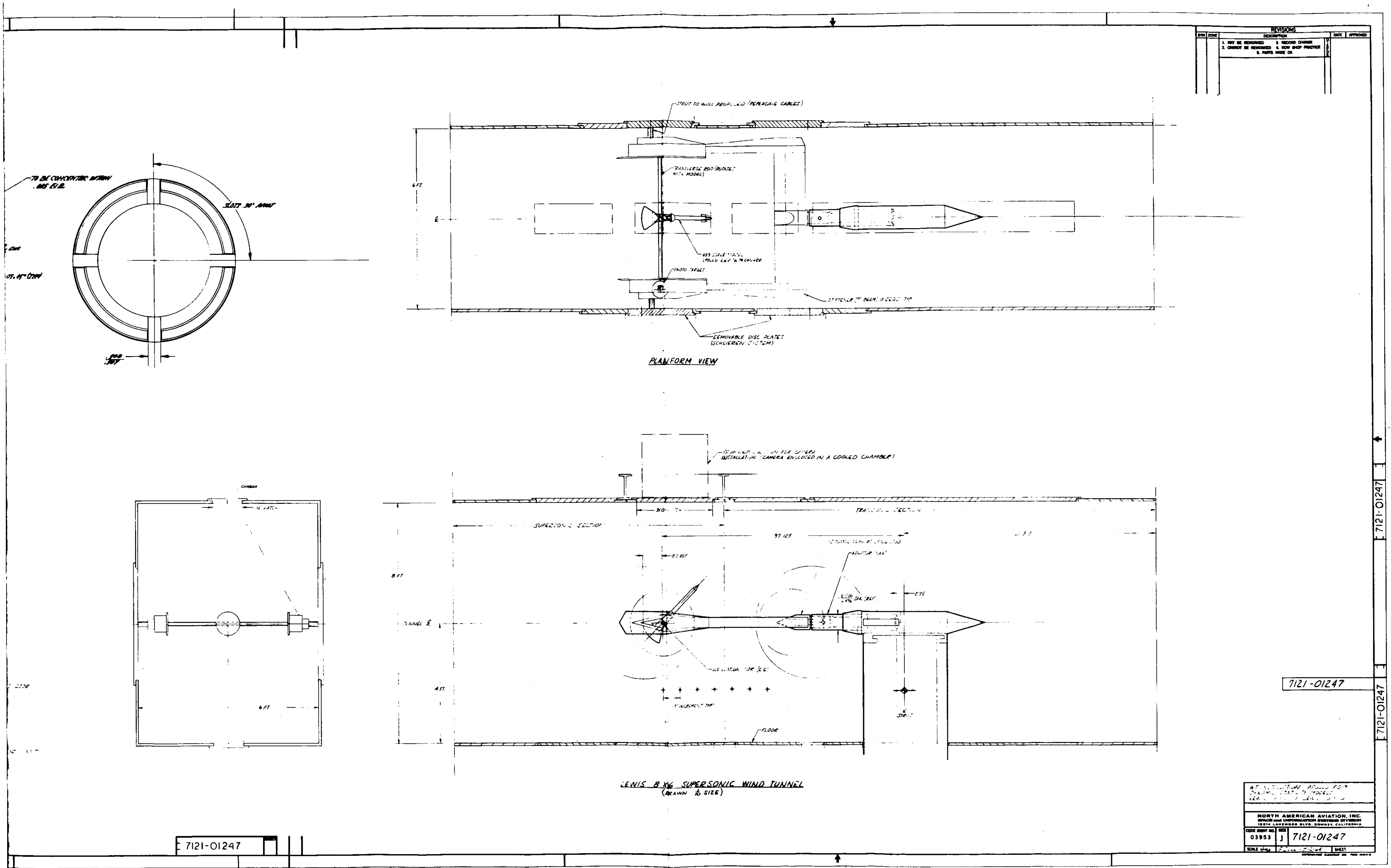


Figure 12. Wind Tunnel Installation Apollo FD-9 Dynamic Stability Models - Lewis 8- by 6-Foot

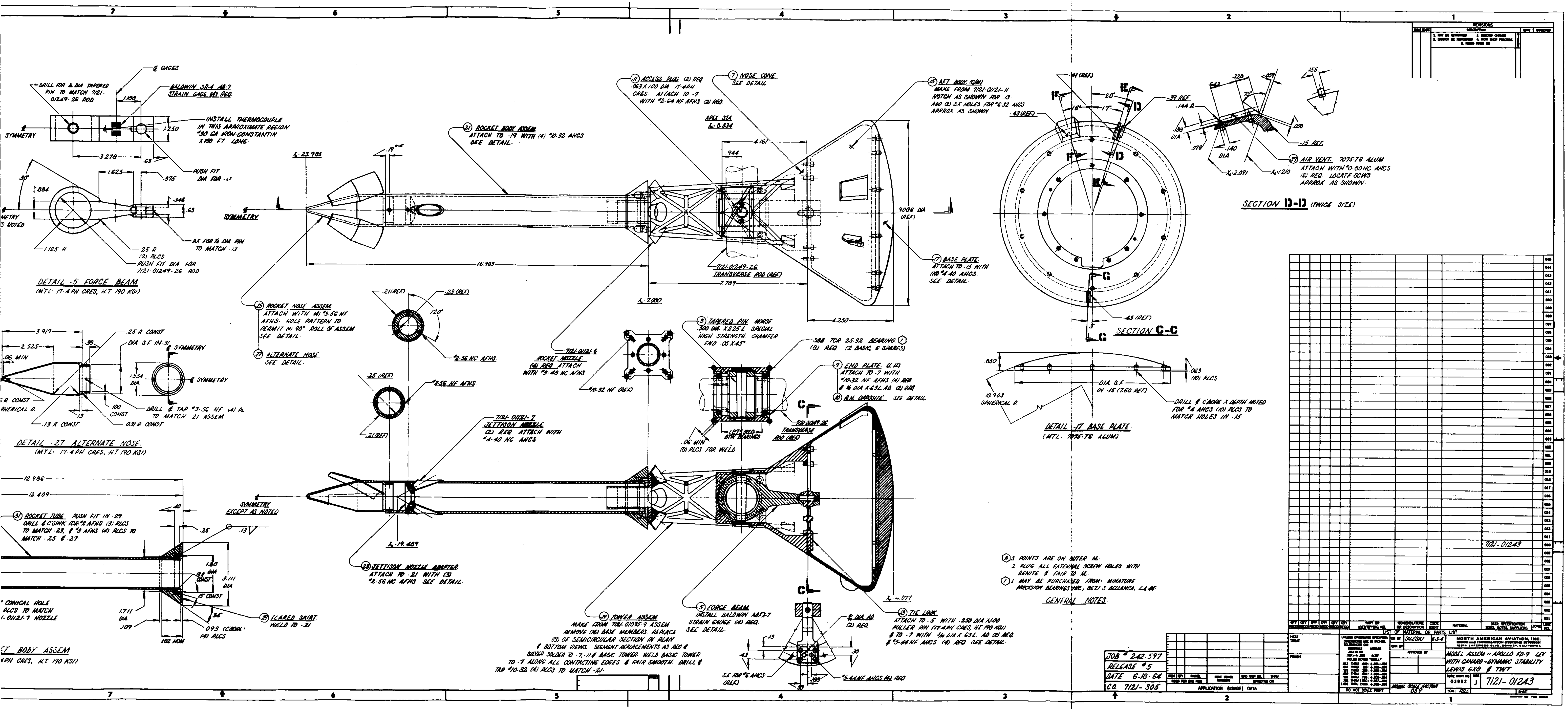
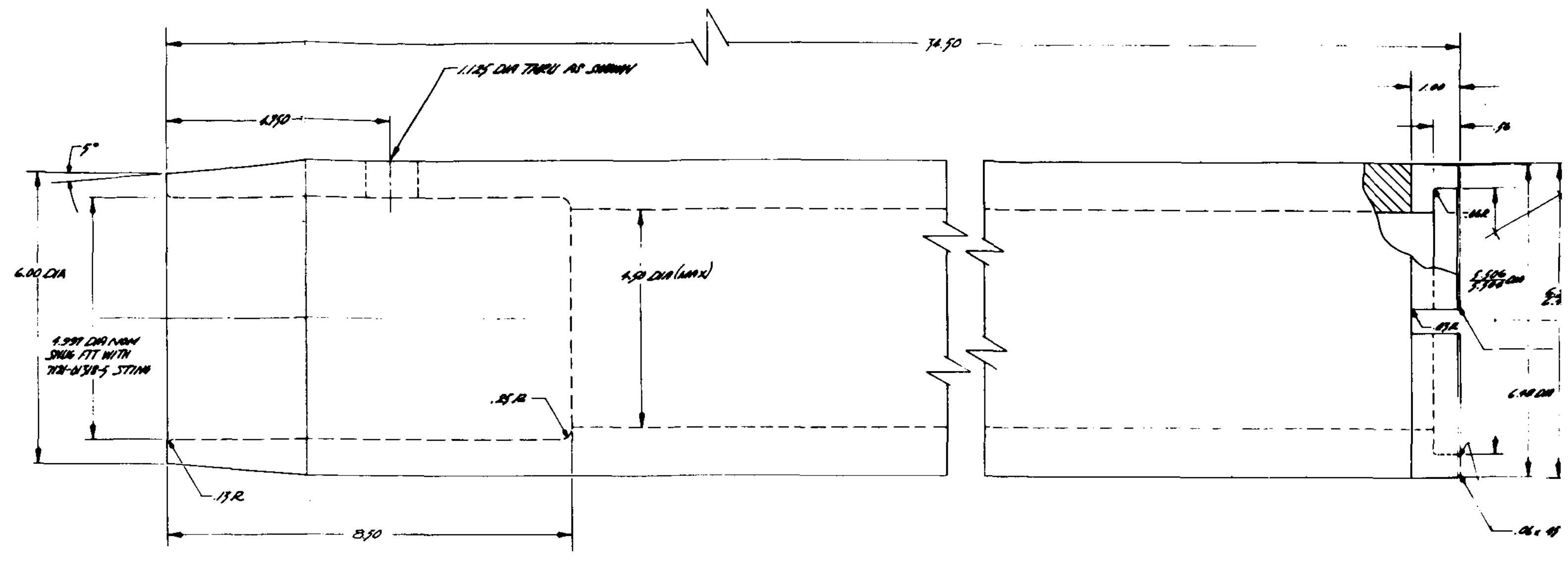
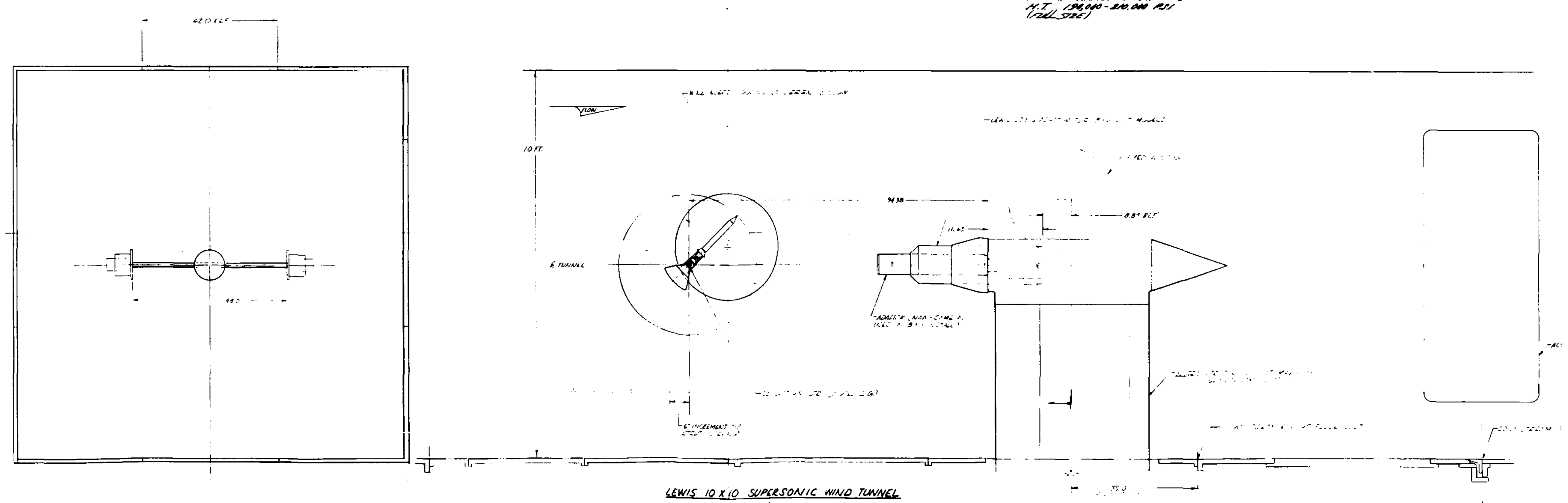


Figure 11. Model Assembly Apollo FD-9 LEV With Canard

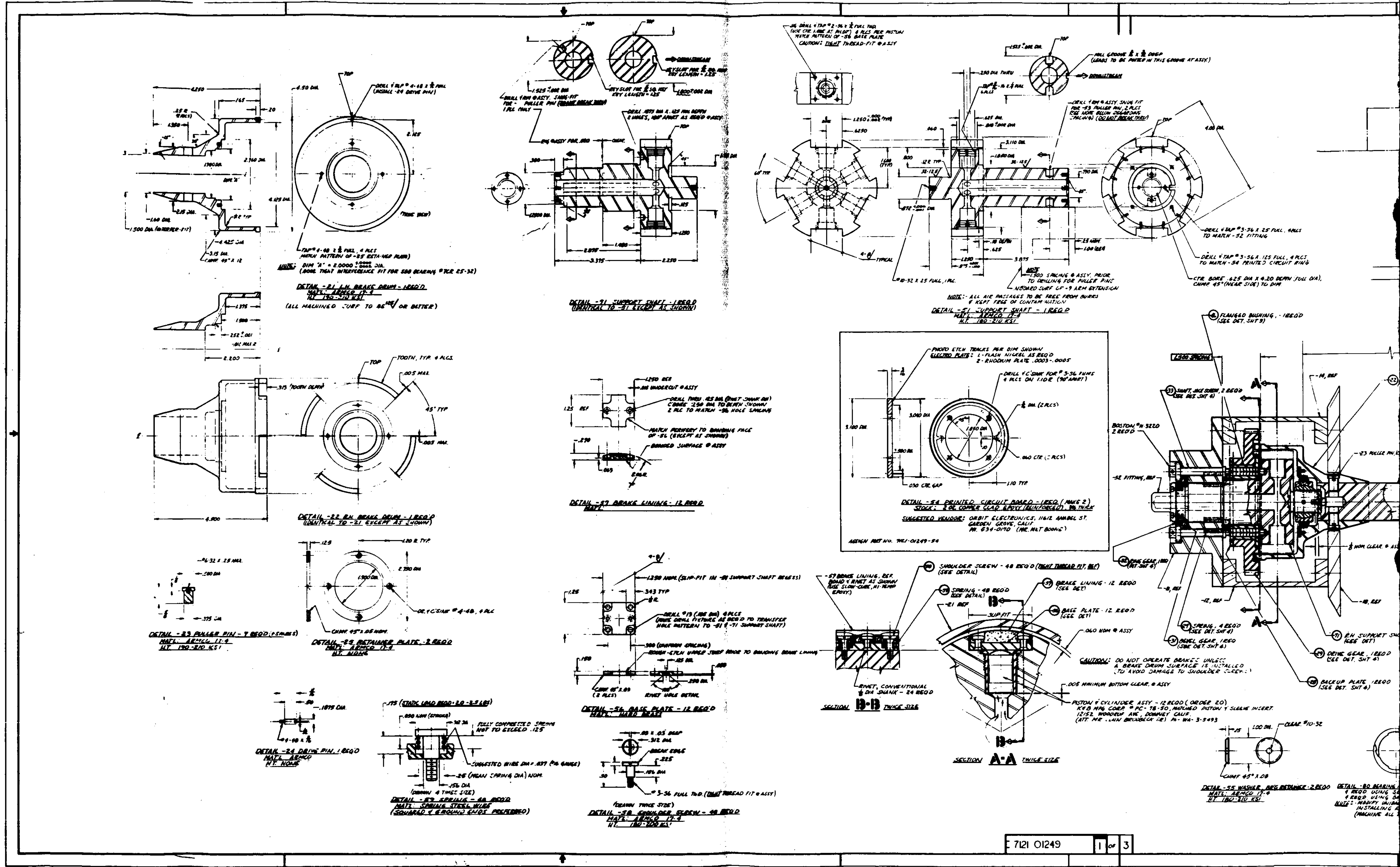


DETAIL - 2 ADAPTOR 1 REQ'D
MAT'L - ARMCO 17-4PH CRES
H.T. 190,000 - 210,000 PSI
(FULL SIZE)



LEWIS 10 X 10 SUPERSONIC WIND TUNNEL
(DRAWN 1/10 SIZE)

E 7121-01247



DETAIL -21 L.H. BRAKE DRUM - 1 REQ'D
DETAIL -22 R.H. BRAKE DRUM - 1 REQ'D
(IDENTICAL TO -21 EXCEPT AS SHOWN)
DETAIL -57 BRAKE LINING - 12 REQ'D
DETAIL -54 PRINTED CIRCUIT BOARD - 1 REQ'D
SUGGESTED VENDOR: ORBIT ELECTRONICS
DETAIL -56 BASE PLATE - 12 REQ'D
DETAIL -58 SHOULDER SCREW - 48 REQ'D
SECTION B-B TWICE SIZE
SECTION A-A TWICE SIZE
CAUTION: DO NOT OPERATE BRAKES UNLESS A BRAKE DRUM SURFACE IS INSTALLED TO AVOID DAMAGE TO SHOULDER SCREW
E 7121 01249
1 of 3

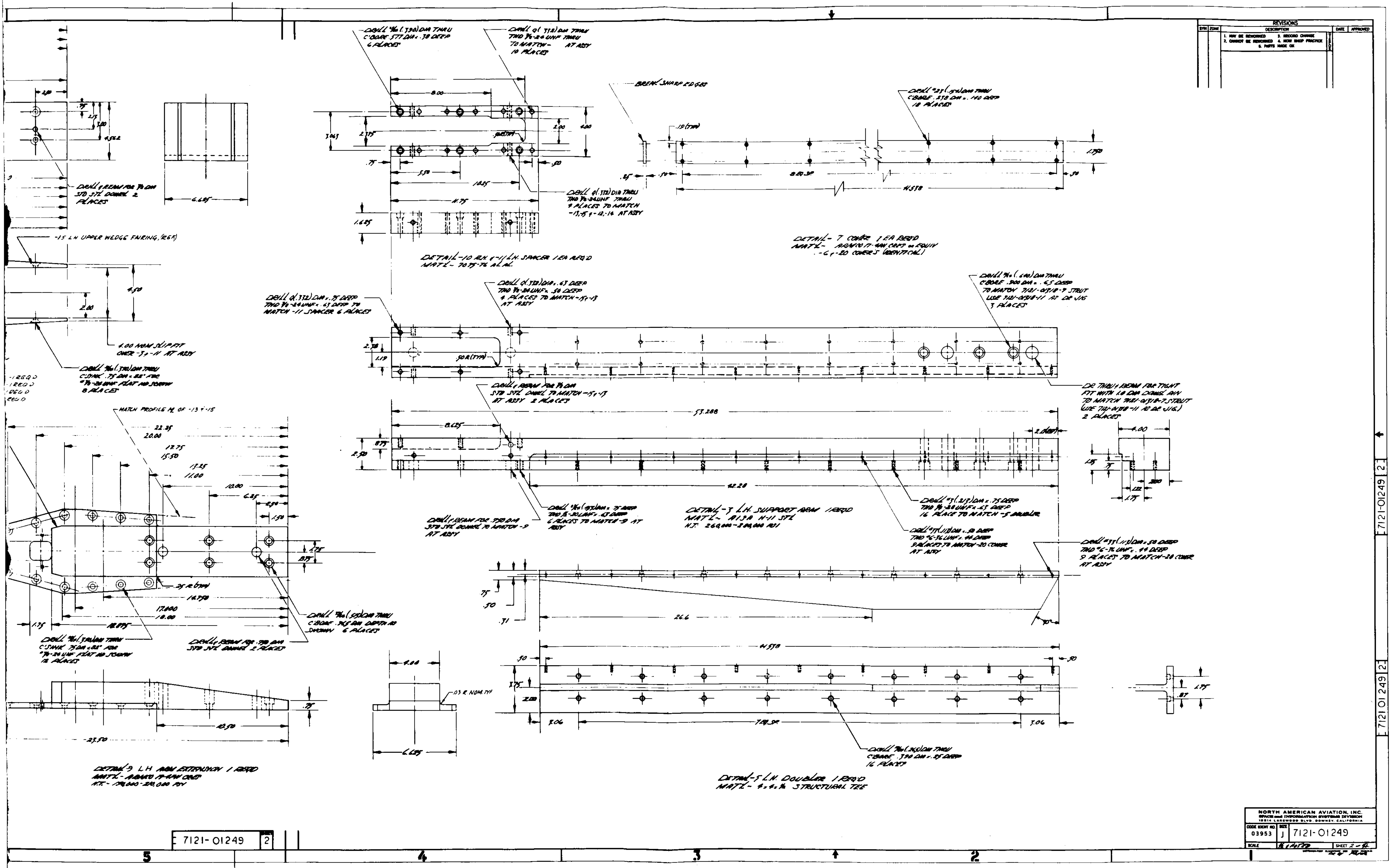


Figure 13. Assembly and Details, Sting, Support, and Remote Control Mechanisms Apollo FD-9 Tests - TWT, Lewis 8- by 6-Foot and 10- by 10-Foot (Sheet 2 of 4)

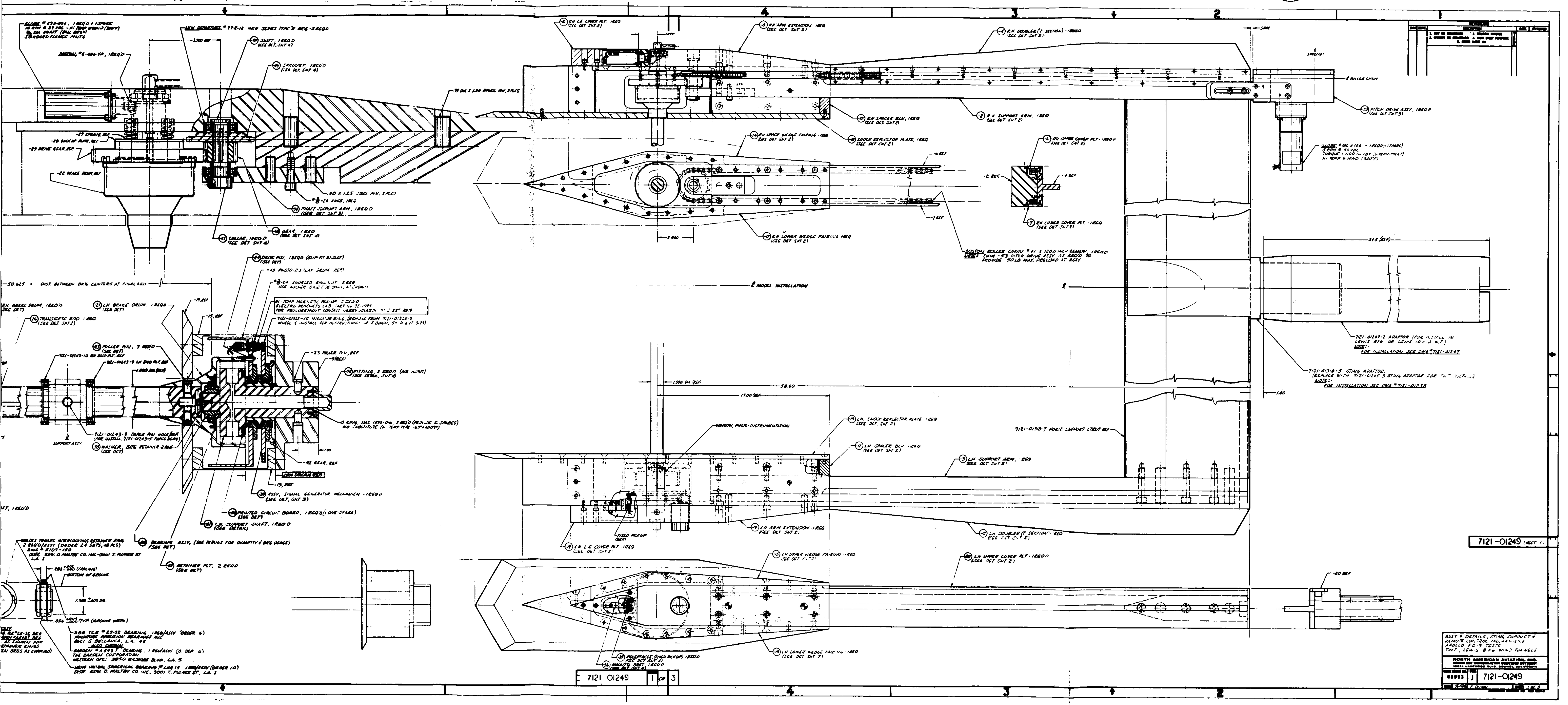
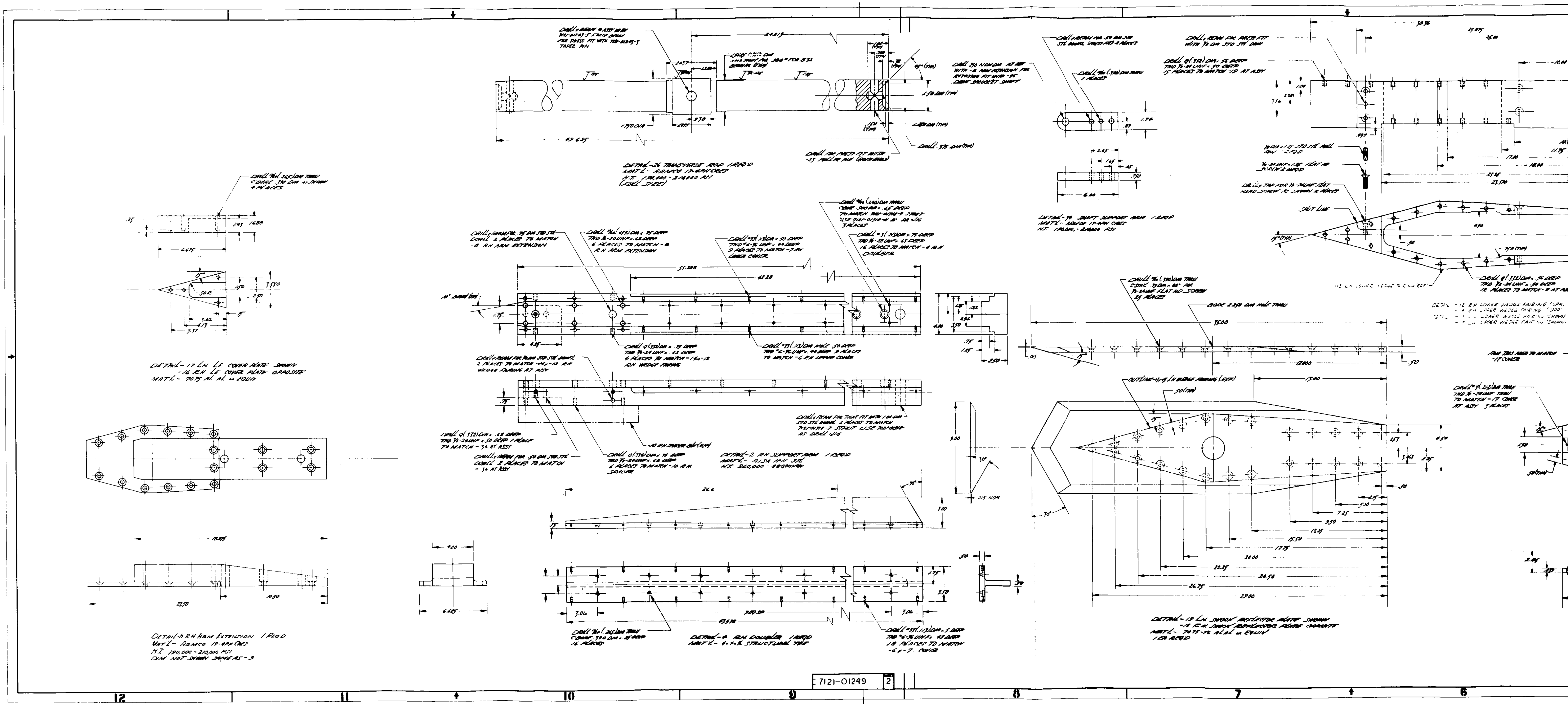
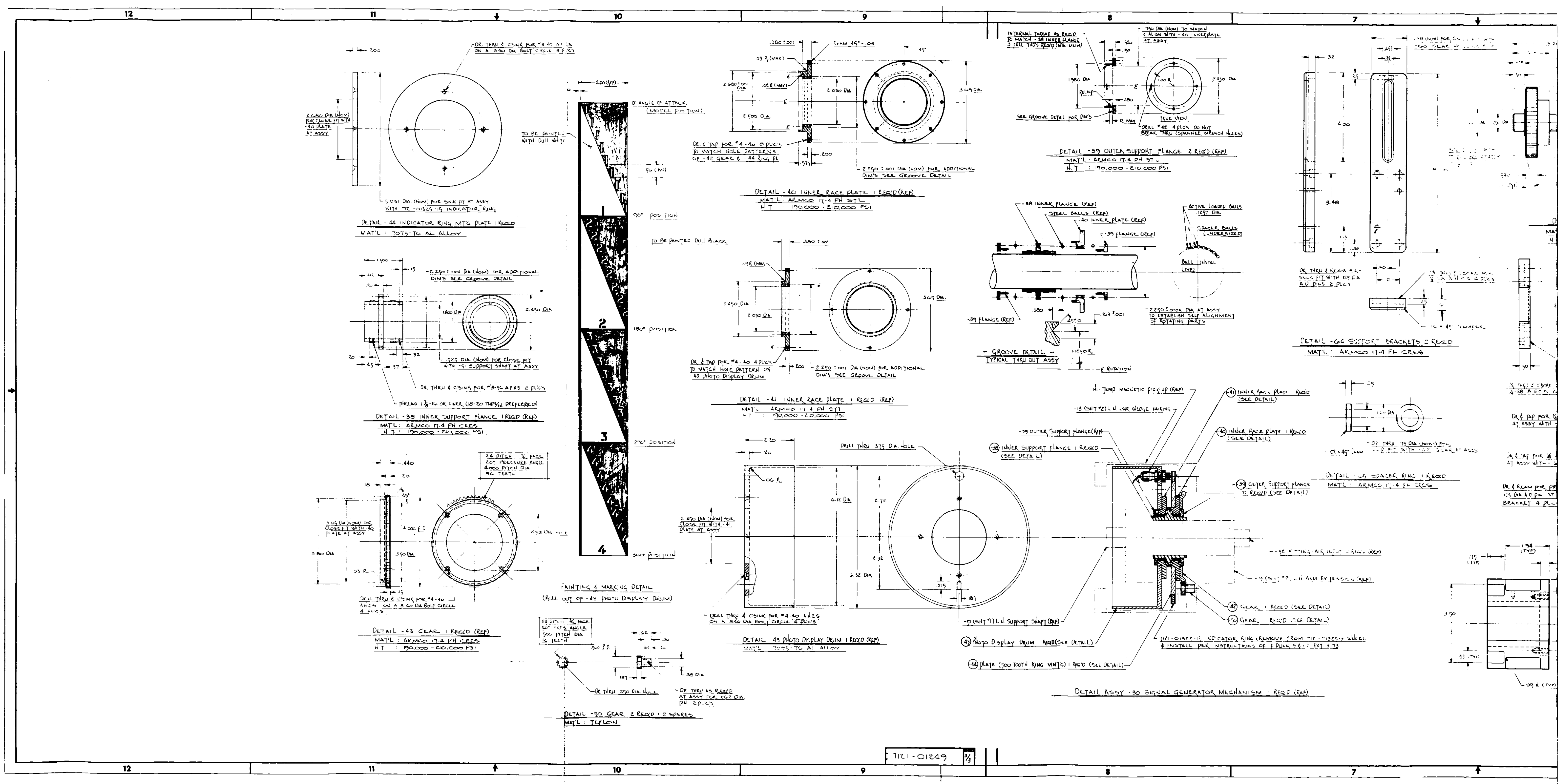


Figure 13. Assembly and Details, Sting, Support, and Remote Control Mechanisms Apollo FD-9 Tests - TWT, Lewis 8- by 6-Foot and 10- by 10-Foot (Sheet 1 of 4)


DETAIL-26 TRANSVERSE ROD 1 REQ'D
MAT'L - ARMCO 17-4PH CRES
H.T. 190,000 - 210,000 PSI
(FULL SIZE)
DETAIL-17 LH LE COVER PLATE SHOWN
-16 RH LE COVER PLATE OPPOSITE
MAT'L - 7075 AL AL or EQUIV
DETAIL-2 RH SUPPORT ARM 1 REQ'D
MAT'L - AISA H-11 STL
H.T. 260,000 - 280,000 PSI
DETAIL-19 LH SHOCK REFLECTOR PLATE SHOWN
-18 RH SHOCK REFLECTOR PLATE OPPOSITE
MAT'L - 7075-T6 AL AL or EQUIV
1 EA REQ'D
DETAIL-8 RH ARM EXTENSION 1 REQ'D
MAT'L - ARMCO 17-4PH CRES
H.T. 190,000 - 210,000 PSI
7121-01249
2



DETAIL -44 INDICATOR RING MTG PLATE 1 REQ'D
MAT'L : 7075-T6 AL ALLOY
DR THRU & C'SINK FOR #4-40 A.F.C.S ON A 3.40 DIA BOLT CIRCLE 4 PL'CS
2.680 DIA (NOM) FOR CLOSE FIT WITH -40 PLATE AT ASSY
5.031 DIA (NOM) FOR SNUG FIT AT ASSY WITH 7121-01325-15 INDICATOR RING
DETAIL -38 INNER SUPPORT FLANGE 1 REQ'D (REF)
MAT'L : ARMCO 17-4 PH CRES
H.T. : 190,000 - 210,000 PSI
2.250 ±.001 DIA (NOM) FOR ADDITIONAL DIM'S SEE GROOVE DETAIL
1.5625 DIA (NOM) FOR CLOSE FIT WITH -51 SUPPORT SHAFT AT ASSY
DR THRU & C'SINK FOR #3-56 A.F.H.S 2 PL'CS
THREAD 1 7/8-16 OR FINER (18-20 THD'S/IN PREFERRED)
DETAIL -43 GEAR 1 REQ'D (REF)
MAT'L : ARMCO 17-4 PH CRES
H.T. : 190,000 - 210,000 PSI
24 PITCH 3/16 FACE
20° PRESSURE ANGLE
4.000 PITCH DIA
96 TEETH
DRILL THRU & C'SINK FOR #4-40 A.F.C.S ON A 3.40 DIA BOLT CIRCLE 4 PL'CS
0° ANGLE OF ATTACK (MODEL POSITION)
TO BE PAINTED WITH DULL WHITE
TO BE PAINTED DULL BLACK
90° POSITION
180° POSITION
270° POSITION
360° POSITION
1
2
3
4
PAINTING & MARKING DETAIL
(ROLL OUT OF -43 PHOTO DISPLAY DRUM)
DETAIL -50 GEAR 2 REQ'D + 2 SPARES
MAT'L : TEFLON
24 PITCH 3/16 FACE
20° PRESSURE ANGLE
.500 PITCH DIA
12 TEETH
DR THRU .250 DIA HOLE
DR THRU AS REQ'D AT ASSY FOR .062 DIA PIN 2 PL'CS
DETAIL -40 INNER RACE PLATE 1 REQ'D (REF)
MAT'L : ARMCO 17-4 PH STL
H.T. : 190,000 - 210,000 PSI
DR & TAP FOR #4-40 8 PL'CS TO MATCH HOLE PATTERNS OF -42 GEAR & -44 RING PL
2.250 ±.001 DIA (NOM) FOR ADDITIONAL DIM'S SEE GROOVE DETAIL
DETAIL -41 INNER RACE PLATE 1 REQ'D (REF)
MAT'L : ARMCO 17-4 PH STL
H.T. : 190,000 - 210,000 PSI
DR & TAP FOR #4-40 4 PL'CS TO MATCH HOLE PATTERN ON -43 PHOTO DISPLAY DRUM
DRILL THRU .375 DIA HOLE
2.450 DIA (NOM) FOR CLOSE FIT WITH -41 PLATE AT ASSY
DRILL THRU & C'SINK FOR #4-40 A.F.C.S ON A 3.40 DIA BOLT CIRCLE 4 PL'CS
DETAIL -43 PHOTO DISPLAY DRUM 1 REQ'D (REF)
MAT'L : 7075-T6 AL ALLOY
INTERNAL THREAD AS REQ'D TO MATCH -38 INNER FLANGE 3 FULL THD'S REQ'D (MINIMUM)
1.750 DIA (NOM) TO MATCH & ALIGN WITH -40 INNER PLATE AT ASSY
SEE GROOVE DETAIL FOR DIM'S
TRUE VIEW
DRILL #42 4 PL'CS DO NOT BREAK THRU (SPANNER WRENCH HOLES)
DETAIL -39 OUTER SUPPORT FLANGE 2 REQ'D (REF)
MAT'L : ARMCO 17-4 PH ST
H.T. : 190,000 - 210,000 PSI
-38 INNER FLANGE (REF)
STEEL BALLS (REF)
-40 INNER PLATE (REF)
-39 FLANGE (REF)
ACTIVE LOADED BALLS .1557 DIA
SPACER BALLS (UNDERSIZED)
BALL INSTAL (TYP)
-39 FLANGE (REF)
2.250 ±.0005 DIA AT ASSY TO ESTABLISH SELF ALIGNMENT OF ROTATING PARTS
GROOVE DETAIL
TYPICAL THRU OUT ASSY
& ROTATION
HI-TEMP MAGNETIC PICK-UP (REF)
-13 (SHT 2) L.H. LWR WEDGE FAIRING
-39 OUTER SUPPORT FLANGE (REF)
-38 INNER SUPPORT FLANGE 1 REQ'D (SEE DETAIL)
-41 INNER RACE PLATE 1 REQ'D (SEE DETAIL)
-40 INNER RACE PLATE 1 REQ'D (SEE DETAIL)
-39 OUTER SUPPORT FLANGE 2 REQ'D (SEE DETAIL)
-42 GEAR 1 REQ'D (SEE DETAIL)
-50 GEAR 1 REQ'D (SEE DETAIL)
-51 (SHT 1) L.H. SUPPORT SHAFT (REF)
-43 PHOTO DISPLAY DRUM 1 REQ'D (SEE DETAIL)
-44 PLATE (500 TOOTH RING MNT'G) 1 REQ'D (SEE DETAIL)
7121-01325-15 INDICATOR RING (REMOVE FROM 7121-01325-3 WHEEL & INSTALL PER INSTRUCTIONS OF E.P.U.N. 56-F EXT 3173)
DETAIL ASSY -30 SIGNAL GENERATOR MECHANISM 1 REQ'D (REF)
DETAIL -64 SUPPORT BRACKETS 2 REQ'D
MAT'L : ARMCO 17-4 PH CRES
DETAIL -65 SPACER RING 1 REQ'D
MAT'L : ARMCO 17-4 PH CRES
7121-01249
3/3
12
11
10
9
8
7

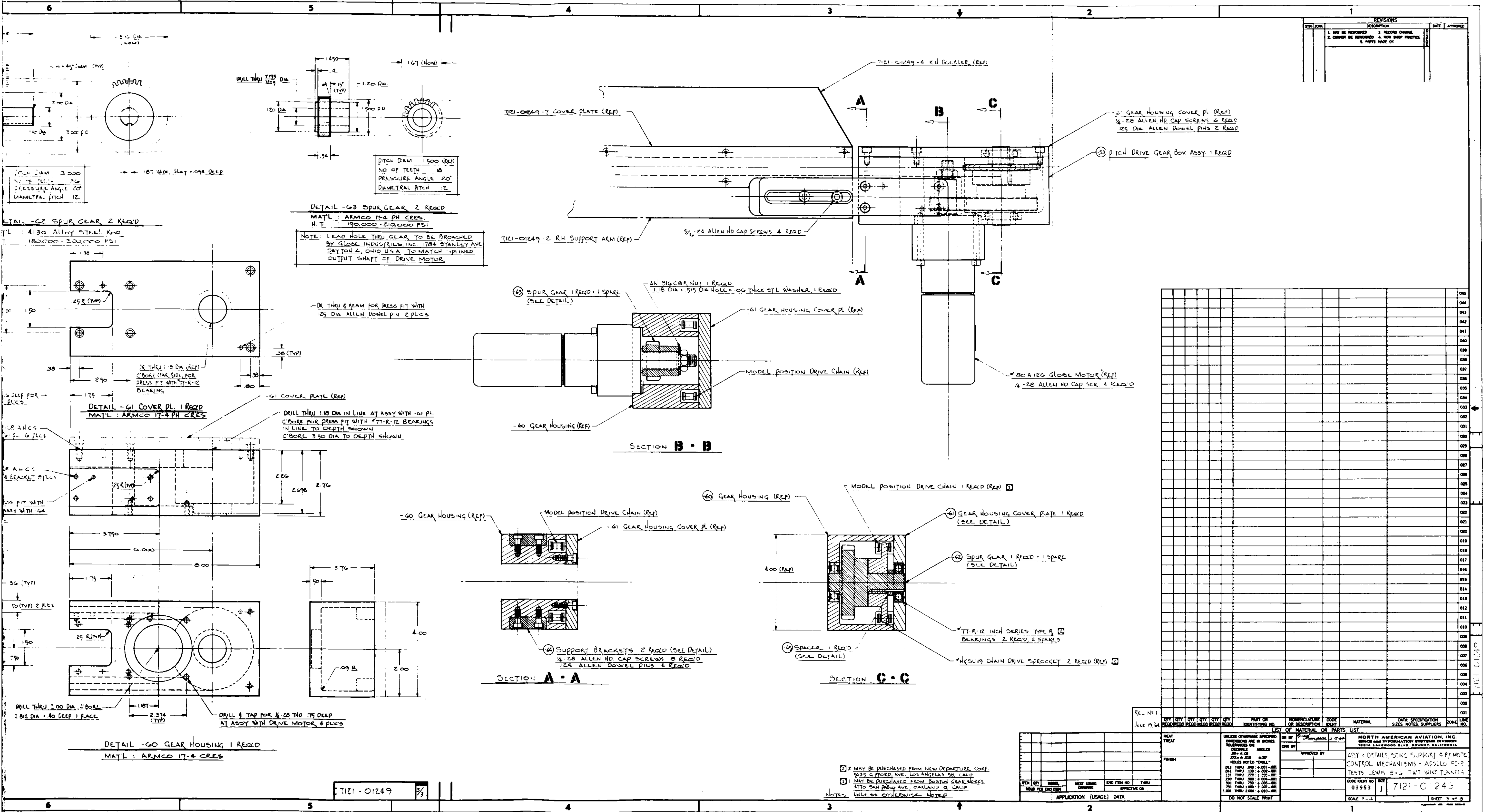


Figure 13. Assembly and Details, Sting, Support, and Remote Control Mechanisms Apollo FD-9 Tests - TWT, Lewis 8- by 6-Foot and 10- by 10-Foot (Sheet 3 of 4)

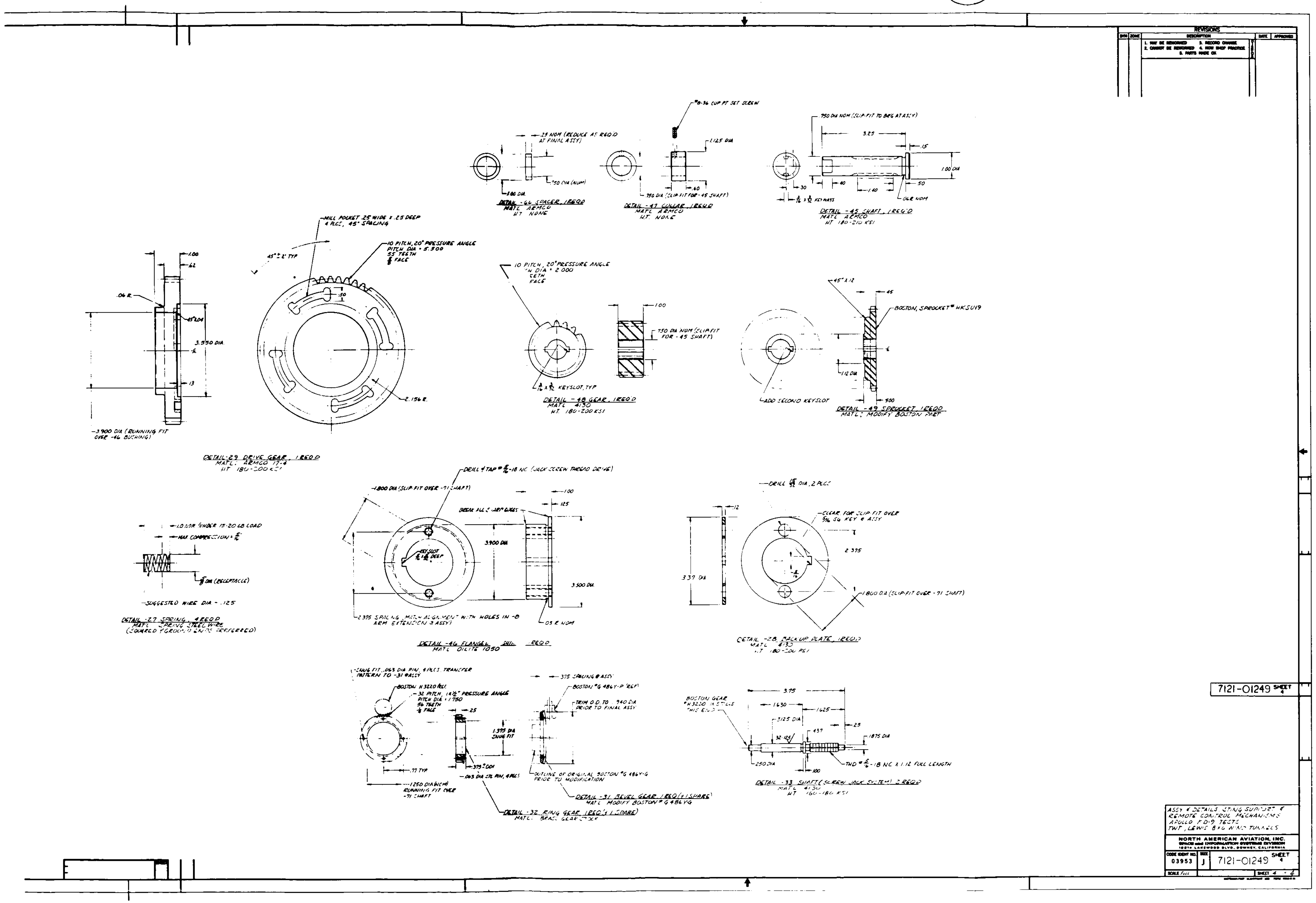
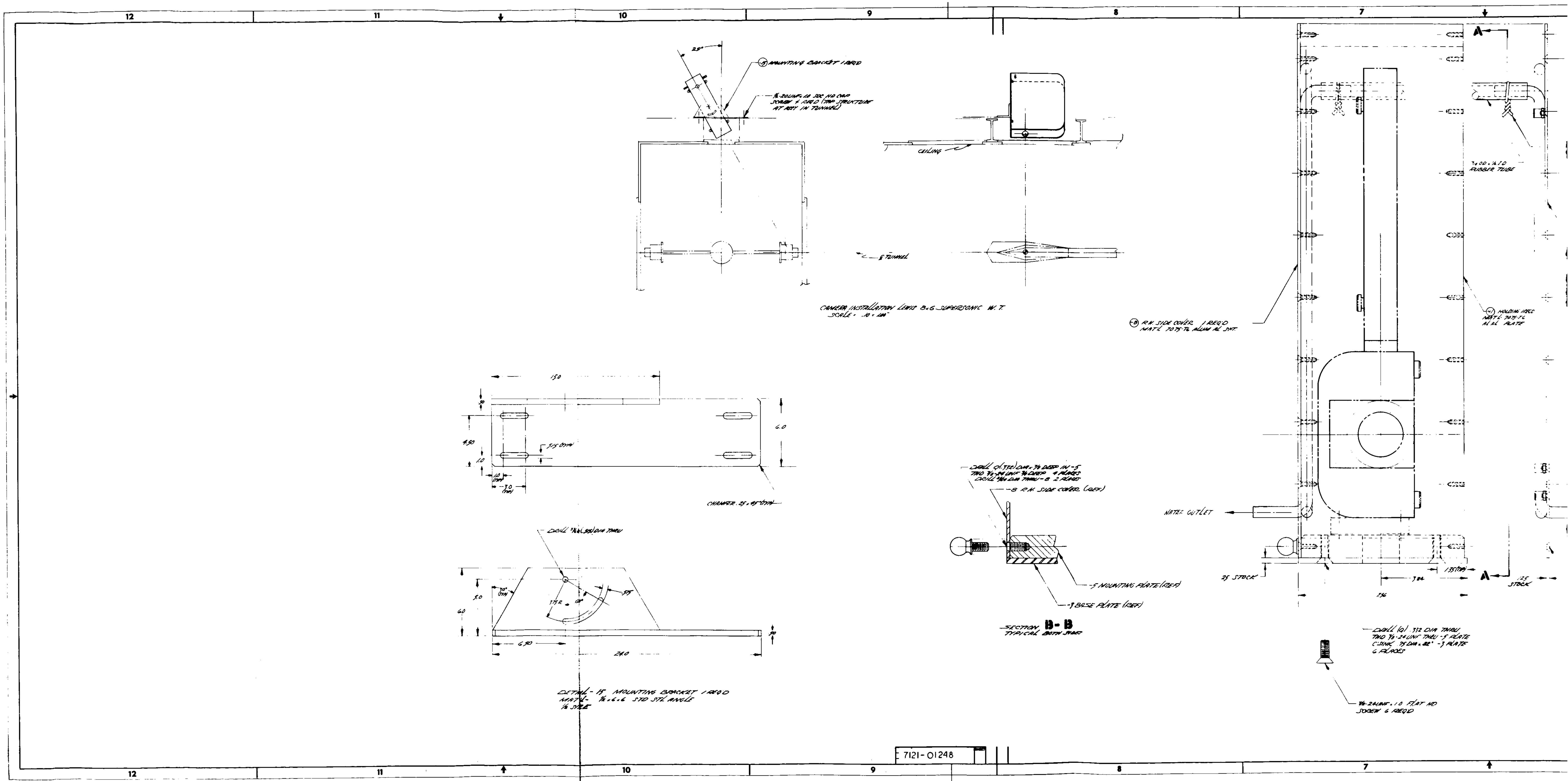


Figure 13. Assembly and Details, Sting, Support, and Remote Control Mechanisms Apollo FD-9 Tests - TWT, Lewis 8- by 6-Foot and 10- by 10-Foot (Sheet 4 of 4)


MOUNTING BRACKET 1 REQ'D
CEILING
TUNNEL
CAMERA INSTALLATION LEWIS 8×6 SUPERSONIC W.T.
R.H. SIDE COVER 1 REQ'D
MAT'L 7075-T6 ALUM AL SHT.
RUBBER TUBE
HOLDING 1 REQ'D
MAT'L 7075-T6
AL AL PLATE
WATER OUTLET
25 STOCK
A
.125 STOCK
6.0
4.50
1.0
24.0
6.90
5.0
CHAMFER .25 × 45° (TYP)
DRILL 9 (.332) DIA × 7/16 DEEP IN -5
-8 R.H. SIDE COVER (REF)
-5 MOUNTING PLATE (REF)
-3 BASE PLATE (REF)
SECTION B-B
TYPICAL BOTH SIDES
DETAIL -15 MOUNTING BRACKET 1 REQ'D
STD STL ANGLE
6 PLACES
SCREW 6 REQ'D
7121-01248

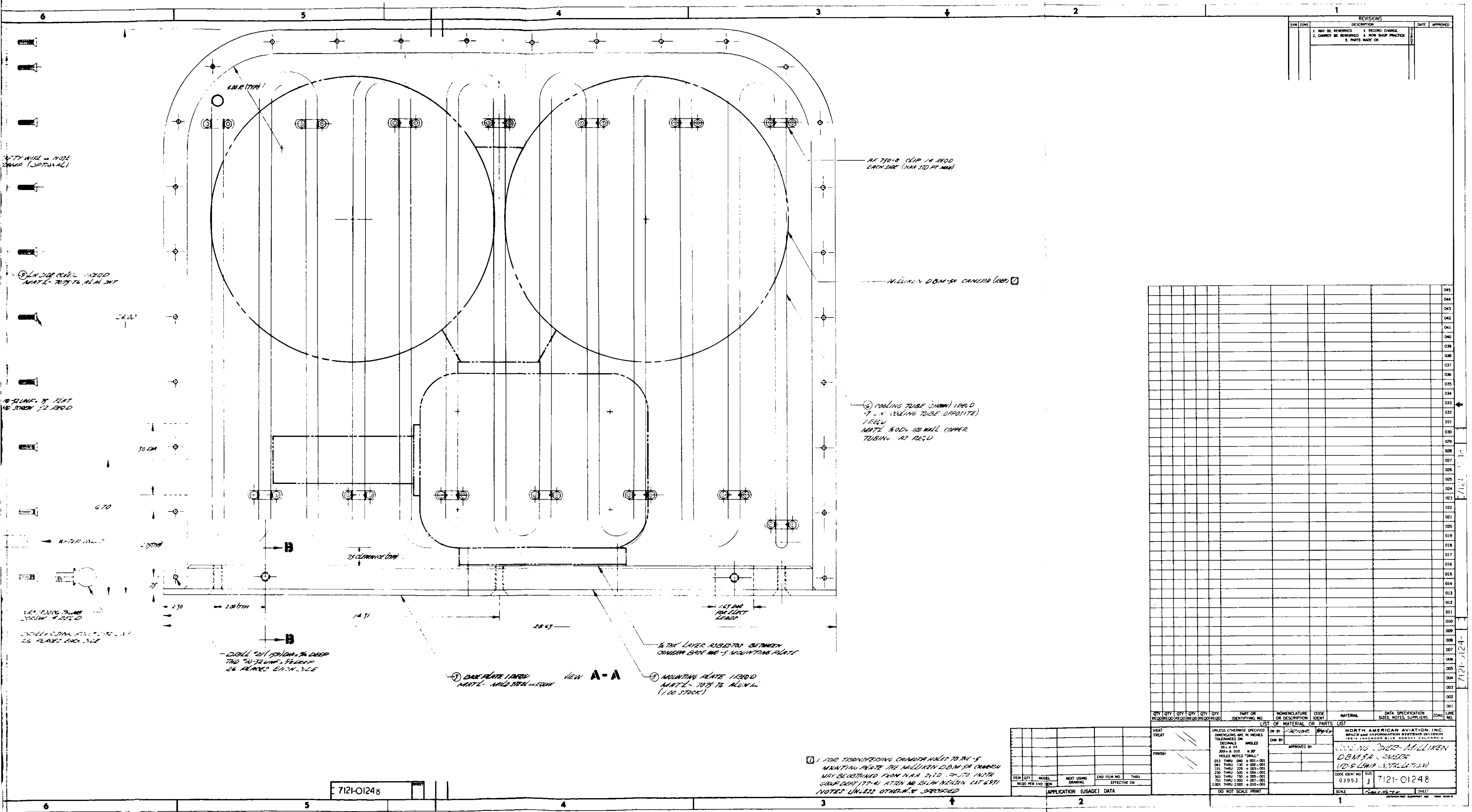


Figure 14. Cooling Cover - Milliken DBM - 5A Camera FD-9 Lewis Installation

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